C.J. Heij[1], C.F.E. Rompas[2] & C.W. Moeliker[1]
[1] Natuurhistorisch Museum Rotterdam
[2] Bogor Agricultural Institute*

The biology of the Moluccan megapode *Eulipoa wallacei* (Aves, Galliformes, Megapodiidae) on Haruku and other Moluccan Islands; part 2: final report

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The Moluccan megapode *Eulipoa wallacei* inhabits forests of several Moluccan Islands (Indonesia). The birds only leave this habitat for the purpose of egg-laying in self-dug burrows on sandy beaches, where solar heat incubates the eggs. The eggs are collected, sold and consumed by local people, a tradition that is said to threaten the species' existence. An intensive study was carried out in the periods June 1994 - June 1995 and January - May 1996 at one of the largest known communal nesting grounds, 'Tanjung Maleo' near Kailolo Village on Haruku Island and at nesting grounds on other islands. In close collaboration with the local people, reproduction data were obtained by daily counts of the number of collected eggs and fledged chicks. Experiments were carried out to establish the incubation period. Egg-laying behaviour was studied with nightvision equipment. The egg-laying interval, home range, inland habitat and provenance of the female birds were established by radio-tracking of nine individuals. Of the 36.263 eggs that were harvested in the 94/95 season (1 April-31 March) peak numbers (max. 211 eggs per night) were found in the dry season (October-March) when 68.4% of the total egg production is laid. 13.7 % of the total egg production was not found by the collectors. Of those eggs, 1.7% got lost otherwise and 12% resulted in fledglings. This apparently ensures (for the time being) enough offspring to keep the population in balance. The total egg-laying population of Tanjung Maleo was estimated at 4200 females. The average egg-laying interval was 13 days. Chicks fledged after an average incubation period of 74.2 days. A fledging percentage of 92.6 for reburied freshly laid eggs indicates good prospects for re-introduction of the species. Female birds were tracked down to South Seram and also appeared to be resident in the secondary forest and neglected cultivated areas of Central Haruku. Surveys to check the status of other known nesting grounds showed many old sites abandoned (e.g. Meti off Halmahera) or diminished numbers of egg-laying birds. Tanjung Maleo (Haruku) and Galela (NE-Halmahera) appeared to be the two remaining large nesting grounds, although on almost all Moluccan islands within the range of the species, medium sized nesting grounds, where substantial numbers of eggs are being laid, were found. New nesting localities were discovered on Buru (scattered along the north coast) and along the northern and southeastern coasts of Seram.

Het Wallace grootpoothoen *Eulipoa wallacei* is een bewoner van (berg)bossen op verschillende Molukse eilanden (Indonesië). De vogels verlaten deze habitat uitsluitend om eieren te leggen in zelf gegraven holen op zandstranden, waar zonnewarmte de eieren uitbroedt. De lokale bevolking verzamelt, verkoopt en consumeert de eieren op grote schaal. Deze traditie schijnt het voortbestaan van de soort te bedreigen. Een uitvoerige studie van deze vogel vond plaats in de perioden juni 1994 - juni 1995 en januari - mei 1996 op één van de grootste bekende legplaatsen, 'Tanjung Maleo' bij het dorpje Kailolo op het eiland Haruku. In nauwe samenwerking met de locale bevolking werden gegevens verzameld van het dagelijks aantal geoogste en uitgekomen eieren. Middels experimenten werd de broedduur vastgesteld. Het nachtelijk eileg-gedrag werd bestudeerd met nachtzicht apparatuur. De eileg-interval, home-range, habitat en de herkomst van de vrouwtjes werden vastgesteld aan de hand van negen gezenderde vogels. Van de 36.263 eieren die in het oogstjaar 94/95 (1 april-31 maart) werden verzameld, werd het maximum aantal van 211 per nacht vastgesteld in februari (droge tijd). In de droge tijd (oktober -maart) werd 68.4% van de totale jaarlijkse eiproductie gelegd. 13.7 % van de gelegde eieren ontsnapte aan de oogst, daarvan ging nog eens 1.7% anderszins verloren en resulteerde 12% in uitgevlogen jongen. Dat percentage is klaarblijkelijk voorlopig voldoende om de populatie in evenwicht te houden. De gemiddelde eileg-interval bleek 13 dagen te bedragen en de gemiddelde broedduur was 74.2 dagen. Een uitkomst-percentage van 92.6 van geoogste en weer herbegraven vers gelegde eieren, geeft goede vooruitzichten voor het verplaatsen van eieren met het oog op de (her)introductie van de vogel. Gezenderde vogels werden teruggevonden in Zuid-Seram en bleken ook het centrale heuvelland van Haruku als leefgebied te hebben. Zoektochten naar legplaatsen op andere eilanden, toonden aan dat veel vanouds bekende legplaatsen verlaten zijn (bv. Meti bij Halmahera) of dat het aantal eieren dat er gelegd wordt, sterk is teruggelopen. Tanjung Maleo (Haruku) en Galela (Halmahera) blijken de enige twee grote legplaatsen te zijn, maar op bijna alle Molukse eilanden binnen het verspreidingsgebied van de soort blijken toch ook nog middelgrote legplaatsen, waar behoorlijke aantallen eieren worden gelegd, voor te komen. Nieuwe legplaatsen werden ontdekt langs de noordkust van Buru en langs de noord- en zuidoostkust van Seram.

Selama periode bulan Juni 1994 - Juni 1995 dan Januari - Mei 1996 di Pulau Haruku, Maluku, telah diteliti biologi dan cara bertelur burung momoa Maluku (*Eulipoa wallacei*). Telah dipastikan lama perkembagan telur beserta pengaruh luar yang mempengaruhinya. Tempat bertelur lama di Maluku diperiksa dan telah ditemukan tempat-tempat bertelur baru. Dalam penelitan ini termasuk cara pengumplan telur oleh pendukuk Kailolo dan adat isiadat yang berkaitan dengan hal tsb. Dicantumkan pula rekomendasi untuk pelestarian dan penglolaan spesies ini.

Correspondence: dr C.J. Heij & C.W. Moeliker, Natuurmuseum Rotterdam, P.O.Box 23452, NL-3001 KL Rotterdam, the Netherlands (all correspondence should be addressed to dr C.J. Heij; c.j.heij@hetnet.nl);
*present address: Christny F.E. Rompas MS (Ikip Manado), Jalan Toar 3/11A, Manado 95112, Indonesia

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CONTENTS

'There are small hens in the jungle, who lay such large eggs, much bigger than duck eggs, that it would be quite a task if you had to eat two of them. I have seen them. These hens, a species of Megapode, lay their eggs into the soft soil at a depth of about one metres or into the sand. After a few days the chicks hatch and dig themselves up from the soil and then run off very fast, like young partridges, so fast in fact, that no one or nothing can catch up with them. It is almost unbelievable, unless you see it for yourself like I and my companions did when we were there on the spot. I have even eaten these hens, they taste allright, although the meat is a bit tough'.

from: Nuñes 1576 (in Jacobs 1974), the first known written report about *Eulipoa wallacei*

1 INTRODUCTION

The megapodes (Megapodiidae) form one of the most peculiar families of birds. This is largely due to their breeding biology which is unique among birds: they use external heat sources for incubation. Microbial respiration, geothermal energy or solar radiation generate heat that causes the eggs, laid in mounds of leaflitter or burrows in the soil, to hatch. Consequently, chicks of megapodes are the most precocial of all bird species: newly hatched chicks are immediately able to fly, are fully self supporting and receive no parental care. Currently, the family comprises 22 species that occur on the Nicobar Islands (India), in eastern Indonesia, Australia, on New Guinea, the Philippines, on Niuafo'ou Island (Tonga) and the Mariana Islands (Southwest Pacific). The center of their distribution lies in the Indo-Australian region, east of Wallace's Line, where the birds generally inhabit tropical forests. Current knowledge of the megapodes is summarized by Del Hoyo et al. (1994) and Jones et al. (1995).

This article concerns the Moluccan megapode, a species discovered by A.R. Wallace in 1858 on the island of Halmahera (Wallace 1860, 1869). It was described by Gray (1860), based on the specimens collected by Wallace[1], as *Megapodius wallacei*, but later workers (Ogilvie-Grant 1893 and, more recently, Roselaar 1994) placed the taxon in a distinct genus, *Eulipoa*, based on colouration and structural characteristics differing clearly from those of *Megapodius*. The species inhabits the Moluccan Islands of Halmahera, Bacan, Seram, Buru, Ambon and Haruku, and the Western Papuan Island of Misool, all within the boundaries of the Indonesian Republic.

Eulipoa wallacei is a forest bird that only leaves its habitat to lay eggs in self-dug burrows at communal nesting grounds situated on sun-exposed beaches or in forest-clearings at sea-level. It is the only megapode that lays eggs at night: one at a time after which the birds return to their inland habitat, in general before dawn. The species' existence is currently believed to be seriously threatened due to the large scale harvesting of eggs at their communal nesting grounds (Collar et al. 1994), a habit that has a history of at least a century (Van Hoëvell 1875; Martin 1894) and is therefore deeply rooted in local human communities which reside close to the birds' nesting grounds (Heij 1995a; Argeloo & Dekker 1996). The breeding biology, population-dynamics, behaviour and other aspects of the birds' life history and ecology are virtually unknown. Most basic data were gathered by early naturalists of the Malay Archipelago (Wallace 1869; Martin 1894). Bird-collectors of the 20th century (Stresemann 1914a, 1914b; Siebers 1930; Heinrich 1956 and Ripley 1960) only added to the understanding of the bird's distribution and taxonomy. The few recent data on the breeding biology, population dynamics and behaviour of *Eulipoa wallacei* result from rather short encounters with the birds and the local human population on communal nesting grounds (De Wiljes-Hissink 1953; Dekker 1991; Dekker et al. 1995). This recent information points at two major communal nesting grounds, one on the island of Halmahera (north of Galela Town) and one on the island of Haruku (Tanjung Maleo near Kailolo Village). There, more than half the species' estimated world population is expected to lay their eggs.

This article reports on the intensive study of *Eulipoa wallacei* carried out at the Tanjung Maleo nesting grounds near Kailolo Village on Haruku Island (Moluccas, Indonesia) during the periods June 1994 - June 1995, January - May 1996 and March-April 1997. Additional data were gathered on other islands within the species' range. Heij (1995a) summarised the scope of this study and presented preliminary results. An Indonesian translation of the first draft of this article was privately published by the first author (Heij & Rompas 1997a). Other publications that resulted from this study are Heij (1995b), Heij (1996) and Heij & Rompas (1997b, 1997c).

Authorship and credits

Within the framework of this study and this article that reports on it, dr Heij is the senior author. He prepared and organised everything: obtained the permits and institutional feedback in Indonesia, raised the necessary funds and made the contacts with the local community of Kailolo Village. The fieldwork was also conducted and lead by him. Rompas took part in this project as an Indonesian counterpart and studied the morphology, karyology and eggwhite-pattern of *Eulipoa wallacei* which resulted in her 'Magister of Sains'-thesis (Rompas 1996, see Appendices 3 & 4). Besides, she carried out incubation experiments in the laboratory and assisted in the field during October -December 1994, March-April 1995, and January 1996. Moeliker acted as the contact back home at the museum in Rotterdam, carried out fieldwork at the nesting grounds and during surveys to other islands in October/November 1994 (Moeliker 1995), worked on the interpretation of the data and was responsible for the editing of the text, tables and figures. Here, Moeliker wants to stress that, although this publication is a multi-authored one, Heij deserves all credits: without his perseverance in the field, his careful collecting of data and his courteous cooperation with local villagers, this investigation would not have taken place.

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[1] Although Warren (1966) listed the presence of three syntypes of *Megapodius wallacei* G.R. Gray 1860 in the BMHN-collection, Robert P. Prys-Jones (in litt. 1996) stated that only two skins, both unsexed specimens collected by Wallace in East Gilolo in 1858, can be considered syntypes. The third skin, a female that Wallace collected on Buru in 1861, does not have the type status as it was obtained after the original description of *Megapodius wallacei* was published.

2 STUDY AREA AND METHODS

STUDY AREA

Tanjung Maleo

The study area is located on the island of Haruku, which together with its neighbouring islands Saparua and Nusa Laut belongs to the Lease Islands of the Maluku (Moluccan) province of Indonesia. This archipelago is situated just south of the much larger island of Seram and east of Ambon Island (Fig. 1A). Haruku (total surface 138 km ^{2}), is located south of West Seram and east of Ambon in the Banda Sea between 128º 24' 30'' E and 128º 32' E and between 3º 30' S and 3º 35' S (de Graaff & Stibbe 1918). The main study area is located on the northwest coast of Haruku, just south of Kailolo Village, on a cape called Tanjung Maleo (Figs. 1B, 1C, 2). It is an area of approximately 12.5 ha (500x250m) where sun-drenched beaches are bordered by a dense coastal forest that changes towards the east into an area with scattered trees (*Plumeria acuminata*) and bushes where the local islamic graveyard is situated. The parts of Tanjung Maleo that are used as nesting grounds by *Eulipoa wallacei* are four open fields (total surface 5450 m^2, 0.545 ha) with a substrate of fine white sand (Fig. 2). Field 1 (the largest: 3000 m^2) is bordered by the southernmost houses of Kailolo, the graveyard to the east and the forest to the south (Fig. 1 C). It has been in use as the local soccer field. Field 2 (1300 m ^{2}) lies directly south of field 1 and is almost completely surrounded by forest. Here a shed was built, from which we carried out nocturnal observations. Field 3 (250 m ^{2}) lies just outside the forest, next to field 2, in the half-open graveyard area. Field 4 (900 m^2) is located about 10 m from the beach, completely surrounded by forest at the southern end of Tanjung Maleo (PLATE I, Appendix 6), close to the site (the 'harbour') where small speedboats leave for Ambon. Here a second shed was built from which most of our nocturnal observations were done. Compared to the other fields, field 4 has a somewhat higher elevation and hence the soil is dryer. Field 4 is the particular nesting ground described by Martin (1894).

From the 'harbour' a narrow road runs south towards Haruku Village and north, along the cemetery, towards Pelauw Village and into Kailolo Village. East of the road that runs into Kailolo there are some old high trees, foodcrop-gardens and fields grown with alang-alang grass *Imperata nucifera* after which a high limestone plateau rizes steeply. On the plateau densely vegetated, neglected gardens predominate and the area slowly rises to a height of about 500 m: Mount Huruano, being the highest point of Haruku.

Vegetation around the nesting grounds

The forest that surrounds the Tanjung Maleo nesting grounds appeared to be of great importance to the Moluccan megapodes. Birds flying in from their inland habitats on Haruku and Seram, stay in the treetops for a while before laying eggs. Birds that could not lay eggs due to late arrival or disturbance, spend the day in the forest (see: chapter 4). For newly fledged chicks it forms the first hide-away (see: chapter 7). Local custom strictly forbids cutting trees for firewood or other uses, although collecting fruit is allowed. The forest mainly consists of trees bearing edible or medicinal fruits. Other, non-useful trees are left alone. Together they form a rather dense, 100-150 m wide stretch of bushes and high trees. Old trees are often overgrown with epiphytes like ferns and orchids. Table 1 lists the most abundant trees, shrubs and (non-grassy) plants that we encountered in the forest.

Kailolo Village

Kailolo is one of the twelve villages of Haruku. Formerly, lots of trees were felled and at present in these open areas there are many gardens with banana, kasbi, vegetables, nutmeg and some sagopalms. The local human population mainly consumes fish and local garden products. The *Eulipoa* eggs form an important source of food, work and income for the community. At least five to seven families earn their living from egg-collecting. Chauvel (1990) judged the socio-economic situation as follows: 'Kailolo is

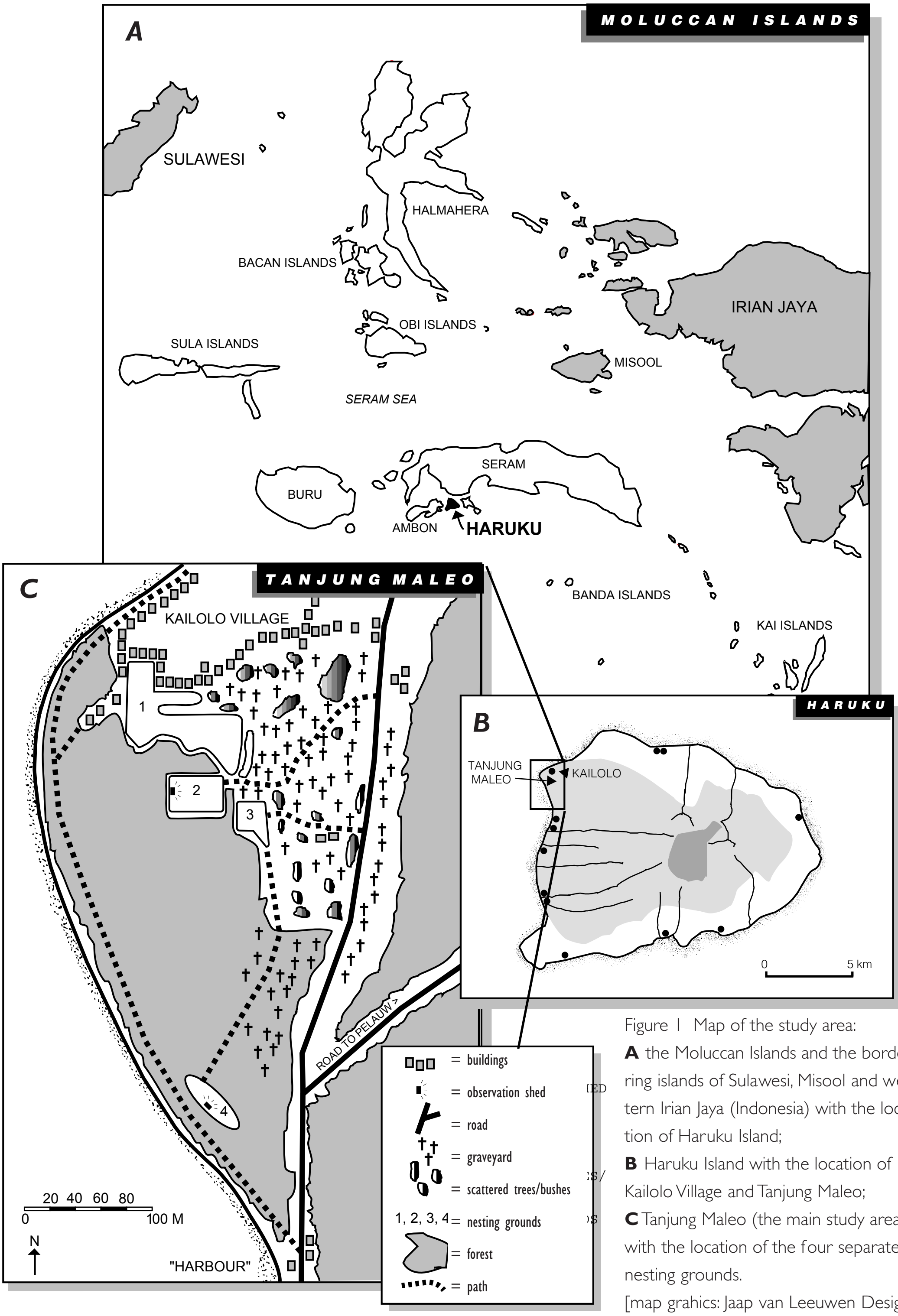

Figure 1 Map of the study area:
A the Moluccan Islands and the bordering islands of Sulawesi, Misool and western Irian Jaya (Indonesia) with the location of Haruku Island;
B Haruku Island with the location of Kailolo Village and Tanjung Maleo;
C Tanjung Maleo (the main study area) with the location of the four separate nesting grounds.
[map grahics: Jaap van Leeuwen Design]

poor in food resources. as n ecessary for their very existence. Motivation and necessity are high and they are quick to seize upon new ideas'.This attitude surely has had a positive influence on the close cooperation we had with the people of Kailolo during this study.

In the Islamic community of Kailolo the women do the hard work. They cut wood in the hills, fetch water from the wells, do the washing and cooking: in short they look after the entire family. Some of the men work as porters in the Ambon harbour and some work in the mountain gardens or are involved in the egg-harvest, but lots are jobless. In 1982 and 1983, respectively , 20 and 30 families transmigrated from Kailolo to Seram. There are a great many children in this village. Family planning has hardly been heard of. In 1994 the total human population was 2508 (1398 men and 1110 women).

Climate and weather

The climate of the Moluccas is very wet, like all mountainous islands around the equator . According to De Graaf f & Stibbe (1918) the coastal areas of the islands around Ambon are among the wettest of the archipelago. The islands are influenced by the monsoon, with mainly southeastern winds from April to November and northwestern winds from December till March. The southeast monsoon causes the presence of cold water from the Banda Sea in coastal areas, whilst the northwest monsoon is strongly guided by the position of the mountainous island of Seram (Fig. 1A). On Haruku, in general, the rainy season lasts from April till September and the dry season lasts from October till March. The average temperature during the year on Ambon Island is 26.3ºC. The average rainfall per year is 1775 mm, of which 1241 mm falls during the rainy season

Table 1 The 20 most noticeab le trees, shrubs and non-gr assy plants in the coastal f orest that sur rounds the Tanjung Maleo nesting ground at Har uku Island, based on: Balick & Mendelsohn (1992); Bell & van Houten (in: Edwards et al. 1993); Hildebrand (1951); Peters et al. (1989); Phillips & Dahlen (1985); Pulle (1952); Sahulata (1984) and van Steenis (1949).

species	local name	type	height (m)	use
Cerbera manghas	Mangga brabu	a	1 - 17	1
Garsinia dulcis	Manggis hutan	a	5 - 20	1
Ficus septica	Siripopar	b	1 - 5	2
Calophyllum inophyllum	Bitanggur	a	10 - 20	3
Ficus benjamini	Beringin	a	3 - 40	3
Canarium commune	Kenari	a	10 - 30	1
Hibiscus tilliacus	Baru	a	5 - 15	3
Plumeria acuminata	Kamboja	a	1.5 - 6	2
Pterocarpus indicus	Lenggua	a	10 - 40	2
Terminalia catappa	Ketapang	a	10 - 35	1
Erithrina variegata	Kayu galala	a	12 - 25	3
Pandanus tectorius	Pandan	a/b	3 - 7	2
Myristica fragrans	Pala	a	5 - 18	1
Scaevola fructescens	Papaceda	b	1 - 3	3
Cassytha filiformes	Tali putri	c	3 - 8	3
Polyscias nodosa	Patatulan	a	5 - 8	3
Lantana camara	Solasi bangke	b	0.5 - 5	3
Mangifera indica	Mangga	a	8 - 30	1
Canavalia maritima	Katang-katang	c	2 - 6	2
Stachytarpeta jamaicensis	Alosa	b	1 - 2	2

1 edible fruit; 2 used for medicine; 3 not used in Kailolo; a tree; b shrub; c creeper

Figure 2 Tanjung Maleo and Kailolo Village (Haruku Island) seen from the air and from the south (the sandy f ields used for nesting by *Eulipoa wallacei* are indicated by the numbers 1, 2, 3 and 4). [photo: C.J. Heij, December 1994)]

Table 2 Weather-parameters obtained at Pattimura-airport, Ambon Island in 1986 (unpublished data, locally obtained).

	temperature °C max.	min.	rainfall (mm)	number of rainy days	relative humidity (%)
rainy season					
April	31.9	23.1	143	20	86
May	31.3	21.6	216	21	86
June	31.2	21.6	208	22	88
July	30.0	21.0	273	21	86
August	29.6	21.2	187	17	86
September	31.3	21.3	214	16	84
total rainy season			1241	117	
dry season					
October	31.9	22.1	54	16	85
November	32.4	22.7	94	9	83
December	33.2	22.0	21	11	78
January	33.2	22.4	139	22	81
February	32.3	22.4	135	20	83
March	32.3	22.4	91	20	86
total dry season			545	98	
yearly total			1775	215	

Figure 3 The egg-harvest administration was accurately kept by the lease holders. As the harvest year begins on 1 April, the month of March has no notes on egg n umbers.

(April-September) and 545 mm during the dry season (October-March). The number of rainy days per year on Ambon is 215 (rainy season 117, dry season 98 days) and the average relative air-humidity is 84.3%: rainy season 86% (84-88%), dry season 82.7% (78-86%). See also Table 2. Because of its protected location (embraced by Seram) Haruku receives less rainfall than the figures given above (Whitten & Whitten 1992).

METHODS

For a general outline of the methods, we refer to Heij (1995a). In addition to this, the period Januari - May 1996 was used to obtain data onthe provenance of birds and the egg-laying interval by radio-tracking of individuals provided with a radio transmitter (see: chapter 8). In March-April 1997 Haruku Island was visited to prepare a re-introduction project and, in addition, a survey on Misool Island was conducted. Specific information on methods used are presented in each chapter.

Time spent at the nesting g round

In order to obtain data on the egg-laying behaviour, the flying in, the predators and the numbers of collected eggs and fledged chicks, a total of 742 hours was spent on the Tanjung Maleo nesting grounds during June 1994 - June 1995 (Table 3). Many hours were also spent together with the villagers of Kailolo and especially with the leaseholder of the Tanjung Maleo nesting grounds, his family and his egg-collecting team in order to obtain data on the local habits and traditions concerning the egg-harvest. Through carefully established contacts with former leaseholders we obtained the daily egg-harvest results, accurately kept on calendars (Fig. 3), dating back to the 1987 lease. During June 1994 - June 1995, egg-harvest data and data on the numbers of fledged chicks were obtained daily by counts carried out in the field by the author(s). Data from the period after 30 June 1995 were obtained through monthly correspondence with the leaseholder(s).

Table 3 Time spent to obtain field-data on the Tanjung Maleo nesting grounds (Har uku Island) dur ing the period 1 June 1994 - 30 June 1995.

period	time	hours spend
mornings	06.00 - 08.00	224
afternoons	13.00 - 14.00	26
evenings	17.00 - 19.00	106
nights	20.00 - 06.00	385
total		741

When not present at Kailolo, most time was spent to visit other Moluccan Islands in search of *Eulipoa* nesting grounds. Then, basic data, such as the number of harvested eggs and fledged chicks and temperature readings were noted on standard forms by the leaseholder or by members of his collecting team. Surveys to other islands were always planned in a way that assured our presence at the Tanjung Maleo nesting grounds during the full-moon period, when most egg-laying birds appeared to be present.

Equipment

The following standard equipment was used throughout the study periods:
- 5 digital thermometers (Thermo-electric, Syntech Original Instruments, Hilversum, the Netherlands)
- thermometer (Veterinar)
- pesola springbalances 100 g, 300 g, 1000 g (the pesola's were regulary gauged at Harapan Goldsmith, Ambon)
- vernier callipers
- altimeter (Barigo, Germany)
- compass (Silva System, Sweden)
- passive night-vision scope PM 5 FG (Delft Instruments Electro-optics, Delft, The Netherlands)
- 10x40 binoculars (Leitz Trinovid, Wetzlar, Germany)
- mini-cassette recorder RQ-350 (National)
- photo camera (Canon Epoca-caption, 35-105 mm)
- naturalist's colour guide (Smithe 1975)

3 THE TRADITION OF EGG-COLLECTING ON TANJUNG

The legend of origin

Although Martin (1894) was the first to describe the nesting grounds and the collecting of *Eulipoa* eggs for human consumption at Tanjung Maleo, the tradition dates back much further. This is witnessed by the legend of origin which is being told in Kailolo and in Piru (West Seram). It was explained to us on many occasions and by many persons. The legend indicates how the birds have come to use the tanjung (cape) with its sandy fields as a nesting ground.

At the heart of the story lies the fact that a man from Kailolo married a woman from Waai (Ambon). In Piru it is said to have been a woman from Piru from the Manupasso family. They had four children who were being teased by the children of Waai. The children asked their mother where their father had come from and she mentioned the village of Kailolo. Soon after, they decided to go there. They walked to the beach near Waai[2] and drew a boat in the sand. The drawing then became a real boat [3]. They arrived in Kailolo with a present from their mother, a golden ball. As soon as they arrived, they started to play with the ball. However, suddenly the ball disappeared into the sand, and they left it for their grandchildren to play with. Almost immediately after these events the 'maleo birds' (*Eulipoa wallacei*) arrived from Pombo, Kasa, Babi, Seram and other islands, to lay their eggs on the beach.

The lease of harvest rights

As a consequence of this legend, Tanjung Maleo is considered to be a miraculous ancestral gift, and thus to belong to the village community. The village feels responsible for the protection of the nesting grounds and the birds and, in return, claims the right to harvest the eggs. In order to have some regulations governing the harvest, a 'sasi' has been established [4]. According to the Kepala Desa (village chief) there has always been a 'sasi' on Tanjung Maleo. However, it seems to have been re-established after the political turmoils in the 1960's. Essential to the 'sasi' is an auction ('lelang') which is held annually on 31 March under the guidance of the village chief (Fig. 4). The highest bidder obtains the right to harvest the eggs from 1 April to 31 March of the following year. The lease period thus begins when the rainy season starts and ends when the dry season has come to an end. No one else, except the people who are employed by the tenant, is allowed to collect even a single egg, a rule that is strictly followed.[5]

According to the Kepala Desa, who in 1994 had been chief for a year, only inhabitants of Kailolo are allowed to take part in the auction. However, the present (94/95 and 95/96) tenant Parit Tuanaya (PeDe) stated that everybody, outsiders included, are allowed to lease the harvest rights. The new Kepala Desa managed to almost double the lease price for the 1994/95 season to 6.105.000 Rupees (then circa US$ 3000) (Table 4). As the nesting grounds are considered communal property, the amount benefits the

Figure 4 The auction ('lelang') for the harvest-rights of 1995/1996, Kailolo Village 31 March 1995. [photo: C.J. Heij]

Table 4 Lease price of harvest rights at Tanjung Maleo and the price of a single *Eulipoa* egg on the local market. Amounts in Indonesian Rp (Rp 1000 = US$ 0.4).

harvest year(s)	lease price	egg price
1992/1993	3.275.000	250
1993/1994	3.670.000	250
1994/1995	6.105.000	300
1995/1996	5.500.000	300
1996/1997	6.300.000	300
1997/1999*	13.000.000	300

* price for two years (see page 101).

village community and is not to be used forother purposes: 25% goes to the Kepala Desa and to the staff of village elders and 75% is to be used for renovation and maintenance of the mosque.

Besides the right to harvest the eggs which is granted to the highest bidder, the 'sasi' forbids to cut wood from the forest that surrounds the nesting grounds and also forbids any hunting. As a consequence, the adults and chicks of *Eulipoa wallacei* are not consumed. Predators of the bird and its eggs - other than man - are poisoned or killed otherwise (Fig. 5). Because of the 'sasi', the support and strong influence of the mosque, and of the high penalty for breaking the rules (the fine is similar to the lease price), hardly any irregularities occur: nobody else collects eggs or takes wood from the forest. Even so, the nesting grounds are under surveillance by the tenant and his collectors, locally known as 'the maleo team'. The only public use of Tanjung Maleo is a path that runs from the village through the coastal forest bordering the nesting grounds. Locals use this as a shortcut to the harbour (Fig. 1C). In July 1996 the island authorities (Camat) placed a fence around Tanjung Maleo, in an apparent attempt to give the area some kind of official protective status (P. Tuanaya, personal communication). The path was, however, still in use. The only other natural resource of Kailolo that is also ruled by 'sasi' are the coconut palms and nutmeg trees. The forest and gardens surrounding the village are divided into three parts and a manager is appointed for each part (kewang). This person receives 10% of each harvest. The sea is not governed by 'sasi'. Fishing by means of home made explosives goes on almost daily. Although commonly condemned, every villager continues to eat fish killed that way.

Figure 5 The lease holder injects poison into an *Eulipoa* egg in order to kill egg predators. [photo: C.J. Heij]

Egg price

The maximum price for which the tenant is allowed to sell an egg is established by the village council and, as a consequence of the communal ownership of the nesting grounds, is being kept at reasonable height. For years an egg was sold for Rp 250 and but after the increase of the lease price in 94/95 by almost 100%, an egg costs Rp 300, an increase of a mere 20% (Table 4).

Economic necessity: more eggs

The high lease price forces the tenant to harvest as many eggs as possible. He not only looks after his own family of five children, but also six men are employed, who also have to maintain their families. To get even (i.e. to earn back the lease price) a simple calculation shows that during the 94/95 season at least 20.350 eggs had to be collected and sold. In order to get some profit, many more eggs have to be harvested. The assumption that the local rules make sure that about 20% of the eggs are deliberately left untouched in order to keep the *Eulipoa* population in balance (Dekker 1991, see also: Del Hoyo et al. 1994; Monk et al. 1997), proved to be wrong. Every morning and even during the night the tenant and his collectors unearth as many eggs as possible with just one purpose: their own survival. The observation of Monk *et al.* (1997) that eggs which are laid deeper than the length of the lower arm of the collector are not harvested, is a myth: we have often seen half the body length of collectors immersed in the sand in an effort to unearth an egg. The lack of interest in the survival of the bird is also shown by their habit of destroying collected eggs that are already hard-set (missed during earlier collecting activities) and not suitable for

Figure 6 Local villagers buy their *Eulipoa* eggs for breakfast on the Tanjung Maleo nesting ground. [photo: C.J. Heij]

consumption. Religious belief rather than insight into the dynamics of the bird population ensures the tenant that Tanjung Maleo and *Eulipoa wallacei* will remain a source of income and food for the village community. The protection, governed by 'sasi', of the nesting grounds and surrounding forest against human activity (other than collecting eggs), surely is advantageous to the bird. Without this measure their nesting habitat would have been lost long time ago.

The eggs are mostly sold locally. In the early morning, when most of the eggs have been harvested, the villagers come to the nesting grounds to buy fresh eggs (Fig. 6). They form an important part of their daily diet. The demand is high, especially during religious festivities and weddings. During the dry season, when the number of collected eggs can reach peaks of more than 200 eggs per day, the surplus is sold on the neighbouring island of Ambon. Argeloo & Dekker (1996) reported eggs from Kailolo being sold in Masohi, South Seram, but we saw eggs from small local nesting grounds being sold there. In Ambon, where the demand for *Eulipoa* eggs is high, the housewives of Haruku sell the eggs through the intermediary of PeDe's brother who works in the Government Office.

The egg-collecting practice

The four to six men employed by the tenant start their daily routine in the late afternoon. Then they work to keep the nesting grounds devoid of any vegetation and plant debris. The fast growing grass (alang-alang) is being removed. They also keep an eye if any illegal activities (e.g. woodcutting) occur. After dinner (at sunset) they congregate in the shed at the edge of field 2 or at the beach and sleep. Every now and then the nesting grounds are checked for digging birds, using torches. They especially disturb birds that are digging early because - in their opinion - the burrows that are dug during the hours close to sunrise, will not be as deep, thus easing the collecting of eggs. Burrows that are believed to contain eggs (for which they have a trained eye) are covered with fresh twigs (Fig. 7). This is to prevent other birds to dig and lay in the same burrow, which, in case it would happen, means a lot of digging and searching (for more than one egg) next morning. In case they encounter a bird in a burrow during a nightly round, they catch it and press the egg out of the body (Fig. 8). The bird is then released. At clear, full-moon nights during the dry season - when most of the eggs are laid - collecting begins already during the night, causing a massive disturbance of the regular

Figure 7 Fresh twigs, placed on the burrows at night, indicate the presence of an egg. The twig prevents the multiple use of the burrow. [photo: C.J. Heij]

laying strategy of the bird (see chapter 4) and casualties among hatchlings reaching the surface. In general, the collecting activities begin at sunrise when the birds have disappeared. The beach of Tanjung Maleo is also checked for burrows. Among the men, there are two so called 'engineers' who are well trained in knowing whether or not there are eggs in a pit. The others assist in digging, filling and tamping the holes (Fig. 9). After about two hours of work (depending on the amount of burrows) the nesting grounds that looked like exploded minefields are smooth

Figure 8 When a Moluccan megapode is encountered in the burrow by the egg collectors, she is caught and her egg is squeezed out. [photo: C.J. Heij]

Figure 9 Early morning collecting activities at Tanjung Maleo (field 1): digging for eggs. [photo: C.W. Moeliker]

Figure 10 After the harvest the collectors take breakfast and count the eggs. For counting, the eggs are always placed in triangular shapes, containing 10 eggs. [photo: C.J. Heij]

again and ready for the next night. The habit of smoothing the nesting grounds after collecting the eggs eases finding new burrows and was not observed at nesting grounds on other islands, e.g. Buru and Halmahera. There, the burrows are not filled after the eggs have been unearthed. It should be stressed that in a natural, undisturbed situation, nesting grounds never look smooth as the birds themselves do not completely fill the burrow after the eggs have been laid.

The team takes breakfast (*Eulipoa* omelettes and rice) at the nesting ground, during which the tenant carefully counts the harvest and makes notes of the numbers (Fig. 10). For the purpose of counting, the eggs are placed in the sand in triangles containing ten eggs each. This triangular shape is present on earthenware plates in possession of Kailolo's village chief (Fig. 11).

Figure 11 The Kepala Dessa (village chief) of Kailolo showing an earthenware plate with triangular egg motives. [photo: C.J. Heij]

Allah and *Eulipoa*: the influence of Islam

Three times a year the Imam (religious leader of the village) and his staff members ('umat') hold an early morning prayer meeting at the nesting grounds to ask Allah to protect the birds and

Figure 12 While the imam and his staff pray for more eggs, the egg-collecting continues. [photo: C.J. Heij]

make them lay many eggs (Fig. 12). For this ceremony, for which the tenant prepares himself all night, mats are spread out on the sandy fields. On the mats small bowls are laid out, each containing 1000 Rupees, one bowl for each high functionary. Apart from this, everybody receives some *Eulipoa*-eggs, the number depending on the harvest results. In August 1994, each official received two eggs. During the prayers and the monotonous singing of 'La Ila Ha Illauallah' in various rhythms, the egg-collectors simply continue to dig for the eggs (Fig. 12). At the end of the praying session the Imam walks over the nesting grounds, throwing rice grains for the birds to grant them fertility.

During private conversations with the tenant PeDe (the first author is fortunate in that he is considered to be one of his family) he kept saying that the high lease price is not very important because he is convinced that the bird will therefore lay more eggs. In addition, a high price is of course profitable for the mosque. On the question 'Does the bird not get angry when every time more is demanded of her?', his answer was that Allah looks after the bird. Even the first author was considered to be a gift of Allah because of his donation of a refrigerator.

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[2] From Kailolo, Waai on Ambon can be clearly seen (the distance is about 6 km).

[3] Every year, during the 'Adat' festivities, a miniature version of the boat ('rasulan') is being built and carried around.

[4] 'Sasi' in the Moluccas is a right, granted to village communities, that governs the ownership of natural resources and agricultural crops from wilderness areas and that regulates the harvest and its finances. It was described, while Indonesia was still under Dutch rule, inArticle 71 of the Internal Government Regulations and of the Finance Department on Amboina and subjected islands (Ind. Stb. 1824 No. 19a). Before govenor J.C.F . Riedel ruled this part of the Dutch East Indies, great use was made of this right. However, as Riedel was against it, 'sasi' has henceforeward hardly been applied (van Hoëvell 1875; Sachse 1907; de Graaff & Stibbe 1918; Volker 1925). Sasi forms part of the 'adat', the customary law which is still deeply rooted in the Moluccan society despite the fact that, in 1967, 'sasi' and all other aspects of the 'adat' were being subjected to Indonesian law.

[5] In March 1990 there were problems amongst the different 'dusuns' (areas in which a village is divided) of Kailolo. Because of these problems, that year no auction was held. Some people did harvest eggs though, but nothing was registered.

4 BEHAVIOUR AT THE NESTING GROUND

Nightly observations at the nesting grounds of Tanjung Maleo and at the bordering beach have revealed the following stages in behavioural patterns connected with egg-laying:

1 flying in
2 exploring and burrowing
3 laying, post-laying and departing
4 returning

There appeared to be a marked difference in behaviour between clear nights and dark nights. Clear nights are common during the dry season (October - March) around the full moon period: the sky is cloudless, the nesting grounds are well lit and there is good vision; observation can also be done using normal binoculars, although with the night-vision scope the view over the nesting ground is perfect. Dark nights are characteristic of the rainy season (April - September): the sky is clouded, the nesting grounds are dark and there is almost no vision; observations can only be done using the night-vision scope. It should be noted though that in the dry season during the new-moon period or during cloudy weather, nights can also be dark. A full-moon during a cloudless night during the wet season also deviates from the average picture (Table 5).

Egg-laying behaviour will be described for both the average clear night and the average dark night. It is the result of the analysis of 25 tape recorded nightly observation sessions (21.00 - 06.00 hours), mostly executed from the shed at field 4 and the bordering beach.

Table 5 Visibility for the human eye at Tanjung Maleo during different weather conditions and different moon stages.

sky	full moon	new moon
clear	++	+-
clouded	-	--

(++ = good; +- = reasonable; - almost no; -- = no).

Clear night situation (see Table 7)

1 Flying in - Observations to establish the number and direction of in-flying birds were carried out during 33 clear nights and lasted from 19.00/20.00 p.m. till 24.00/01.00 p.m. Observation sites were situated along the beach next to the nesting grounds and north of Kailolo, the hills just northeast of Kailolo and at at sea off the northwest coast of the island. Observations were carried out simultaneously from two or three sites. Despite these efforts, only few birds were actually seen flying in (Table 6), however egg-collecting activities proved that large numbers of birds had been present at the nesting grounds. On nights with e.g. 200 egg-laying birds, we were only able to observe about five birds flying in, indicating that the vast majority arrived out of our sight or (unlikely) during the late night hours. Most of the birds we saw flying in, arrived from a northerly direction, although birds were also observed flying in from the south and southeast, and from the west (over the sea) (Table 6). All birds arrived solitarily. Flying-in started about 15-30 minutes after dusk and lasted all night. At the site northeast of Kailolo we did not observe any arriving bird, although at the nesting grounds we did see (and mostly heard) birds flying in from the east. Victims of the electricity wires that run along the road just east of the nesting grounds and birds that collided with motorcycles on that road indicate that birds arrive from easterly directions as well.

Table 6 Direction from which birds (*Eulipoa wallacei*) arrived at the Tanjung Maleo nesting ground, based on observations during 33 nights along the beach, at sea and in the hills east of Kailolo.

direction	number of birds	number of nights	average per night
N / NW	30	9	3.3
W	5	4	1.3
S / SE	25	24	1.0
E / NE	-	-	-
total	60	33	1.8

We expect birds arriving from northerly directions to originate from South Seram, situated just opposite of North Haruku. Birds that reach the nesting grounds from southerly and easterly directions probably belong to two populations: (1) birds that reside in Central Haruku (see: chapter 8) and (2) birds originating from the Elpaputih Bay region and more easterly areas of Seram. They cross inland Haruku to reach Tanjung Maleo. Birds arriving from a westerly direction, may originate from the population that is expected to inhabit mount Salahutu on Northeast Ambon (Dekker et al. 1995; Jones et al. 1995), though we believe they more likely belong to the population that resides in the Piru Bay area of Seram. These birds probably cross via Kasa Island and turn left in an easterly direction once they reach Northeast Ambon or Pombo Island. In general, the birds fly in at tree-top height. Into headwinds, coming from northerly and westerly directions, they first land on the beach north of, or next to, Tanjung Maleo. Burrowing movements occur at the beach. Especially on windy, clear nights many burrows are found on the beach. Eggs are also laid on the beach when the birds have been disturbed at the nesting grounds during full moon nights. As a consequence, regular egg collecting on the beach takes place. Birds have only been seen or heard to arrive solitarily, one at least some minutes after the other.

As soon as an adult bird (hereafter called ‘she’) arrives on Tanjung Maleo, she clumsily lands in the trees, making a lot of noise in the foliage with her flapping wings. She especially prefers to sit on thick parallel branches where she can also walk up and down. After some time in the tree (a maximum of 30 minutes was observed, but it might take longer), she flies down towards the nesting ground.

2 Exploring and burrowing - Now there are two scenario’s: either the recently landed bird is the first one at the nesting ground (solitary), or several birds are already active there (group).

Solitary - When the bird is the first to arrive on the nesting ground, the exploration starts at the edge, close to the forest. She observes the area while standing stock still for five to fifteen minutes with her neck stretched and tail hanging down (PLATE II). Then, often, she takes a few (mostly five) steps to the right and to the left, then stops and looks around. She repeats this display two to five times. Every now and then she makes burrowing movements by scratching the sand four to five times with left and right foot, followed by a few halting steps to the left and to the right. She then turns 180º and walks back a few metres. This display is regularly repeated. At every stop the neck is stretched. If the bird remains alone, she will eventually dig her burrow at the dark, shady edge of the field. Within two minutes she may totally disappear under the surface. During burrowing, she continuously changes direction or she might start again at a different place. This may last for hours: several birds were observed exploring and burrowing for two to three hours before they had started the next stage, laying the egg. To summarize: on clear nights, solitary birds have trouble starting, they take a long time to burrow several pits which lead to different directions. This hesitating behaviour is probably influenced by uncertainty and fear: a solitary bird is more vulnerable than a group.

Group - When other birds are already present on the nesting ground, the bird lands (mostly in the vicinity of the other birds) and upon arrival, familiarizes herself with the surroundings and rather promptly walks haltingly, neck stretched, in the direction of the others. She looks at the burrowed pits and is often chased off by the ‘owner’ with excited ‘kek-kek-kek’ calls. Depending on the hour and the quietness (no human disturbance) of the night, she will start to burrow her own pit within three to five minutes after arrival. This common, clear-night situation is given below:

23.06-23.10 h: Full moon, clear sky. After a brief human disturbance, nine birds are active. Bird 1 lands in the centre of the nesting ground, does not move for about two minutes, looking around and stretching her neck, then walks about 5 metres, looks left, right and back. Then she walks in the direction of bird 2 while making burrowing movements with her feet. The two birds meet at

a distance of about one metre, both with necks stretched, jerkingly looking to the left and to the right. They both utter calls like 'kek-kek-kek' and 'kew-kew-kew'. Birds 1 and 2 observe the burrowing movements made by bird 3, which then chases them away. Birds 1 and 2 walk around attentively, necks stretched, now and then away from each other, always looking around. Now bird 1 starts to burrow and bird 2 continues her way, looking left and right, making burrowing movements and walking over the field in hairpin patterns, tail hanging down, neck stretched. Bird 3 stops burrowing where she was and starts all over again at a different spot: within one minute she totally disappears under the surface, every so often peeping over the edge of the pit. Birds 1 and 2 burrow at a distance of two metres from each other, emerge from the pits, approach each other and start to fight by pecking, kicking and fluttering like two domestic cocks *Gallus domesticus*. They return to their own pits. The only thing we see now is sand being thrown up out of two pits in all directions. Every now and then a bird peeps over the edge of the pit.
23.10 - 23.15 h: Birds 1 and 2 emerge from their pits and start digging somewhere else. Bird 1 returns to her first pit, stays under ground and throws up sand in all directions. Bird 1 comes out of her pit and walks over to bird 2, which has also started to dig at a different spot. This new burrow is abour one metre from bird 1's pit, so that by throwing up the sand, they partly refill each other's pits again. Bird 2 comes out of her pit, has a look at bird 1 and is chased off. From the direction in which the sand is thrown up out of the burrow, it is evident that under the surface bird 1 has turned 180º and is burrowing in a different direction. Birds 1 and 2 emerge from their burrows and look at bird 3. Bird 4 joins in. They all start kicking and fluttering. At one instance four birds are burrowing within four square metres. Bird 1 emerges from her pit, chases off bird 3 which moves away and starts digging somewhere else. Seeing the shadow of a bird flying over, bird 3 presses herself against the ground. There are now five birds burrowing within four to five square metres. Many 'kek-kek-kek' and 'kew-kew-kew' sounds are heard. Now bird 2 leaves her burrow and starts all over again in a different spot. A critical distance during digging appears to be essential. This is expressed by flapping of wings and kicking. More time is now spent displaying this agressive behaviour. Two 'new' birds closely pass our shed while making soft grumbling noises ('grr - rrr, greeee').
23.15 - 23.25 h: Now six birds are burrowing within four to six square metres. Birds clearly seek each other's company. Everywhere on the field, groups of birds are burrowing (Fig. 13). There is much walking about between groups. Their 'kek-kek-kek' calls fill the night, sometimes deafened by the loud wailing cries of Forstens

Figure 13 About twelve Moluccan megapodes during nightly digging activities at field 4 of Tanjung Maleo. The white vent is clearly visible in most birds. [photo: C.J. Heij]

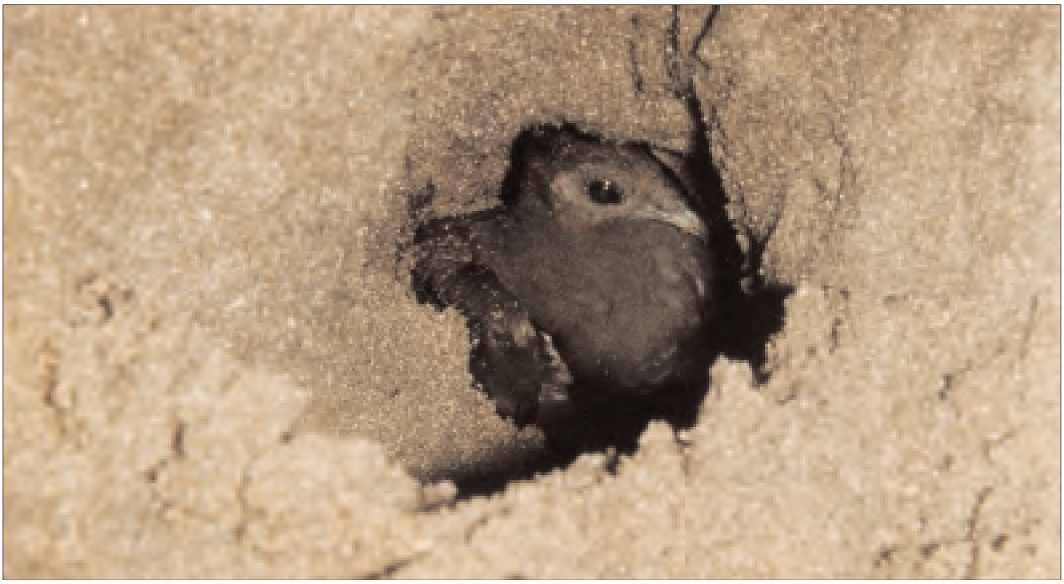

Figure 14 A Moluccan megapode in her burrow, in the egg-laying position, at Tanjung Maleo. [photo: C.J. Heij]

megapode *Megapodius forstenii forstenii*. Birds do not display the behavioural patterns of the exploring phase.
23.25 - 24.00 h: A total of 43 birds is burrowing in five groups that are more or less evenly spread over the field. Newly arrived birds do not display the exploring behaviour, but start burrowing immediately.
24.05 h: Now 53 Birds are active in six groups.

3 Egg laying, post-laying and departing - After having dug three or four pits, the female disappears for several minutes into one of the burrows. She enters head-first in order to turn around at the bottom so that she will be looking upward (Fig. 14). The egg is laid within a few minutes. After having laid her egg, she emerges, shakes her feathers and scrapes a little sand into the pit. She then digs a little more around the pit into various directions and chases off neigbouring birds. Sometimes she digs a few small pits in another area and then returns to the burrow that contains her egg, scraping some more sand into it (post-laying behaviour). When the bird flaps her wings and stretches her legs, it is a clear sign that she will leave the nesting ground. Sometimes a bird will run some metres before flying to a tree at medium height, but mostly she takes off directly. During clear nights, after displaying the post-laying behaviour, birds were always observed to fly into the trees first before they depart from Tanjung Maleo and return to their forest habitat on Haruku, Seram or other islands (returning behaviour).

4 Returning - The birds returning to their habitat, mostly first fly across the beach bordering Tanjung Maleo and continue flying to the west in the direction of Ambon. Then, at a distance of 50 to 100 m from the coast, they seem to reorientate and choose a more definite direction. In most cases birds were seen to fly back over Tanjung Maleo just above treetop height in an easterly direction or more to the north over the trees parallel to the coastline. The initial returning direction of nine birds fitted with transmitters (see chapter 8, Table 26) was approximately SE (n=7) and NE (n=2).

Dark-night situation (see Table 7)

1 Flying in - This stage is basically similar to the clear-night situation. Landing in the trees and finding a suitable branche is even more noisy.

2/3 Exploring, burrowing and laying - The birds that have been present all day in the forest surrounding the nesting grounds and have not been able to lay their eggs during the preceding night (see below), already start to burrow along the edges of the nesting ground even before dusk. Before it gets really dark (between 18.00-19.00 p.m.) the burrows dug by the early birds may already contain eggs. These pits are always situated at the edge of the field close to the forest. The early birds fly off and leave Tanjung Maleo immediately after having laid their eggs. The newly arrived birds wait in the trees, exploring the field. They do not become active before the sky becomes clear. Then they descend from the trees and start to burrow rapidly, displaying little exploring behaviour. When there are regular clear moments, most birds have become active by 04.00 and at 06.15 a.m. all behavourial patterns, including egg-laying, have been carried out. When the entire night is very dark or when there has been a lot of disturbance (mostly human: the collectors), the burrowing and egg-laying procedure is concentrated around dawn, between 05.30 and 06.30 a.m. Then, they walk and dig in a noisy way, almost as if hurrying each other up. They regularly use existing burrows. In one case we even observed a bird burrowing a new pit and laying her egg within 13 minutes. As a consequence, dark-night pits are less deep than clear-night pits (see: chapter 5). During these early morning hours, the collectors do not disturb the birds since the eggs will be easily found.

3/4 Departing and r eturning - Birds having laid their eggs at dawn and those who have not been able to lay at all, do not fly into the trees but simply walk into the forest. Before they really get out of sight, they congregate at the edge of the forest (Fig. 15) and walk through dry fallen leaves. This behaviour resembles foraging, but picking food has never been observed. It is during this stage that agressive interactions between *Eulipoa wallacei* and *Megapodius forstenii forstenii* are common. There are several mounds of the latter species at the edge of the nesting grounds and *Eulipoa* was regulary observed near them. They were even seen burrowing in the mounds (Fig. 16). Those burrows were not finished and did not contain eggs. Toxopeus (1922) and Siebers (1930) mentioned the (same) find of an *Eulipoa* egg in the mound of *Megapodius forstenii buruensis* on Buru and judged it as parasitic behaviour. This was considered highly unlikely by Jones et al. (1995) since the eggs of both species are indistinguishable. Our observations indicate that *Eulipoa* does dig burrows in the mounds of *Megapodius forstenii*, though not as a parasitic egg-laying strategy but accidentally, when the mounds are located at the pheriphery of the nesting grounds.

Figure 15 A Moluccan megapode close to the forest edge at Tanjung Maleo. [photo: C.J. Heij, March 1996]

Figure 16 A mound of *Megapodius forstenii* at Tanjung Maleo showing burrows of *Eulipoa wallacei.* [photo: C.J. Heij]

At (or just before) dawn *M. forstenii* becomes active around their mounds. Fighting, like the intraspecific aggresive display, resembles two fighting domestic cocks: lifting the body by wing flapping and kicking with both feet. *M. forstenii* is the aggressor and clearly dominant: when approached by a running *Megapodius*, *Eulipoa* runs away. It seldom comes to fighting as described above. At first sunlight all birds have disappeared into the forest. There they flock together all day, staying low and running around like partridges *Perdix perdix*. They utter the 'kek-kek-kek' or 'kuk-kuk-kuk' calls almost continuously. Because these noisy calls, we could easily locate them in the forest. Only when we approached them within five metres, or when we persistingly chased the groups, they would clumsily fly into the trees while making a lot of noise. During the morning, groups from all four fields join together in the forest. The largest congregation that we observed consisted of 40 birds. They were never seen to leave Tanjung Maleo on the wing during hours of daylight. Probably they will do so during the following night. It should be noted that birds that manage to lay their eggs during a clear moment before dawn, do depart from Tanjung Maleo on the wing and return to their habitat. Also nightly burrowing in the forest on sandy patches has regulary been observed (during dark nights), but there the soil temperature is expected to be low and eggs will probably not hatch. This might be subject to future research.

Males: present or absent at the nesting grounds?

Males and females of *Eulipoa wallacei* are indistinghuisable in the field, and even museum-skins are hardly separable on basis of plumage characters (Jones et al. 1995; Rompas 1996). The presence or absence of males at the nesting grounds is therefore difficult to establish and should be based on differences in behaviour of the sexes and/or gonadal/cloacal inspection of captured birds. Dekker (1991), Dekker et al. (1995) and Jones et al. (1995) suggested, based on incidental observations of two individuals remaining close together while digging and egg laying at the Tanjung Maleo nesting grounds, that male and female visit the site together. Our observations do not support this. We did regulary see birds, while digging burrows, behave differently e.g. more upright stance, more aggressive towards neighbouring birds. However, close observations with the night-vision scope revealed that those birds (n=33) in the end had dug a

Table 7 Summary of the activities of *Eulipoa wallacei* during clear nights and dark nights at Tanjung Maleo, Haruku Island. See text for explanation.

activity	exploring	burrowing/laying	departure	return
clear night	on field prolonged	all night prolonged deep	flying via trees	same night
dark night	from trees	clear moments or dusk/dawn fast less deep	walking forest floor	next night*

* only in case of egg-laying at dawn

full-depth burrow and when caught, appeared to have laid an egg (n=13, estabished by cloacal inspection and/or the find of the egg) or still had the full size egg in the body (n=29; local collectors habitually collect the egg by pressing it out). Furthermore, we did not observe any behaviour that indicated both sexes to be present: no courtship or copulation was seen.

In addition to this, during 38 nights the totalnumber of digging birds at Field 4 was established by nightly counts and compared with the total number of burrows and the number of eggs laid (harvested eggs, established during the early morning hours, together with the number of eggs not found by the collectors established by a calculation based on counts of fledged chicks, see chapter 9). In total, 1419 birds present at field 4 dug 3384 burrows which yielded 1410 eggs (1 egg per 2.4 burrow , on average 37.3 birds and 37.1 eggs per night). These figures indicate that all birds that visit the nesting grounds actually lay eggs and hence are females. The fact that there are more burrows than eggs, does not mean that the surplus is dug by males. Why these 'mockpits' are not used is not clear. Temperature or humidity might not be favourable, although most mockpits are found in clusters of burrows, indicating the abiotical factors to be good. Mockpits are no doubt a nuisance to predators of eggs (including humans), so there might be an anti-predator strategy involved.

Dekker et al. (1995) and Jones et al. (1995) did, however, not supply conclusive evidence for the male presence at the nesting grounds, and mentioned that four birds they caught at Tanjung Maleo and five birds collected at a nesting beach on Buru by Siebers (1930) were all females. A worldwide inventory among 33 institutions shows that in natural history collections, adult male specimens are underrepresented: of 33 sexed specimens, only 21.2% are males (Table 8). When these specimens of known sex are correlated to the habitat from which they were collected, a clear picture emerges (Table 9): all 15 specimens known to be collected on nesting grounds (Tanjung Maleo [Haruku], Wa'kasi and Wai Pate [Buru], Galela and Sidangole [Halmahera]) are females. Dekker et al. (1995) argued that the method likely to be used mostly to collect *Eulipoa* at nesting grounds - trapping while inside the burrow - might favour females being caught. The seven adult birds we collected (Table 8), however, were all victims of electricity wires and, after checking their gonads, also appeared to be females. Of nine specimens from an inland habitat (mount Sibela [Bacan], Fakal [Buru], Hatu Sake [Seram] and Tamulol [Misool], seven (77.8%) are males. With females regulary being away for egg-laying purposes, there appears to be a greater chance to collect males in the inland habitat. For specimens of which the habitat could not be retrieved from the labels, the sex ratio is not so heavily biased. When chicks are concerned, the sex ratio of specimens in museum collections is also more or less even (Table 10). In this analysis we assume that all museum-specimens, of which the label indicated the sex, were sexed anatomically and trustworthy. In the case of three out of three specimens collected on Misool by Ripley (Table 8) being males, we have some doubt. Sexing these specimens using DNA-techniques would be the solution.

As there is no conclusive evidence of males being present at the nesting grounds, both from field observations and specimens in museum collections, we conclude that nesting grounds are only visited by females. In other burrow-nesting species, the Polynesian megapode *Megapodius pritchardii* and Melanesian megapode *Megapodius eremita*, the female also has no male company while digging and laying (Jones et al. 1995). Vogel (1996) concluded from the study of colour-ringed Polynesian megapodes that territorial behaviour of males is restricted to feeding territories and that the male stays behind when the female leaves for egg-laying.

Voice

Eulipoa wallacei is a noisy bird during egg-laying activities. They almost constantly uttered sharp 'kek-kek-kek' or 'kuk-kuk-kuk' calls. The same voice was heard while groups of birds reside in the forest surrounding the nesting grounds during the day, indicating that it is a contact-call. Besides, at night on the nesting grounds, the birds regulary produce a grumbling sound 'grgrgrgrgrgrgr' that was only audible from close distances (< 4 m). Dekker et al. (1995) also mentioned the 'kuk-kuk-kuk' calls and added 'ki-ouw kouw' and 'kou-kouw-kouw-kouw'. The latter two calls were never heard by us. Wallace (1869) attributed 'loud wailing cries' to the species and De Wiljes-Hissink (1953) mentioned 'noisy crowing at the beach'. We believe both authors were wrong. No loud cries uttered by *Eulipoa* were ever heard by us at the nesting grounds, although we commonly heard nightly cries of *Megapodius forstenii* (at Haruku and Buru) and *Megapodius freycinet* (at Halmahera) that deafened all other sounds. The 'crying and crowing' mentioned by Wallace and De Wiljes-Hissink most probably refer to (one of) these species, whose mounds are often found near nesting grounds of *Eulipoa*. The voice *Eulipoa* produces while in its inland habitat, and the call of the male are not known to us.

Table 8 Numbers, sex and provenance of adult specimens of *Eulipoa wallacei* in the collections of thirteen Natural History Museums, based on a world wide inventory (n=33). Localities of male specimens are underlined, those of females are in italics; combinations do occur. [ANWC Canberra, HLMD Darmstadt, MCML Liverpool, MNHN Paris, MZST Turin, NFSR Frankfurt, NHMV Vienna, NMB Basel, UMMZ Ann Arbor, UZMC Copenhagen, ZFMK Bonn, ZMH Hamburg, ZMZ Zürich and ZSM München have no holdings of *Eulipoa wallacei*; KBIN Brussels, MGD Genova and MBL Lisbon did not respond; abbreviations of institutions according to White & Bruce (1986)]

collection	total number of adult specimens	number of sexed specimens	number of male specimens	provenance
AMNH New York	8	5	3	*Bacan*[1], Seram[2], *Ternate*
BMNH Tring	3	1	-	Halmahera[3], *Buru*[4]
FMNH Chicago	1	-	-	Seram
MCZ Cambridge (USA)	2	1	-	Seram, *Ternate*
MZB Bogor	7	7	1	*Halmahera*[5], *Buru*[6]
NMR Rotterdam	7	7	-	*Haruku*[7]
PMNH New Haven	4	3	3	Misool[8], Bacan[9]
RMNH Leiden	6	4	2	Seram, Halmahera, *Ternate*
SMTD Dresden	1	-	-	Ternate
UMB Bremen	1	-	-	Halmahera
USNM Washington	8	3	1	*Halmahera*[10], Misool[8]
ZMA Amsterdam	3	1	-	Halmahera, *Buru*, Ternate
ZMB Berlin	1	1	1	Bacan[1]
totals	52	33	11 (21.2%)	

1 Mount Sibela, altitude 1500 m, collected by Heinrich (1956).

2 Hatu Sake, altitude 1000 m, one male collected by Stresemann (1914a).

3 two syntypes, collected by Wallace (Gray 1860; Warren 1966).

4 Wai Pate nesting ground, one female collected by Wallace (1863).

5 one female from Sidangole nesting ground (collected by Vorderman) and one male from an unknown habitat, collected by De Haan.

6 of five females, four are from the Wa Kasi nesting grounds (collected by Toxopeus) and one is from the inland habitat near Fakal (Siebers 1930).

7 all victims of electricity wires or traffic at the Tanjung Maleo nesting ground, collected by Heij during this study.

8 Tamulol, altitude 100 - 300 m, collected by Ripley (1960, 1964).

9 Mount Sibela, one male collected by Ripley (1960).

10 Pasir Putih village near Galela nesting grounds, two females collected by Taylor.

Table 9 Habitat type where 33 adult specimens of *Eulipoa wallacei* of known sex were collected. Sex ratio for each habitat is given (see Table 8).

habitat type	nesting ground		inland/mountainous		unknown	
sex	male (%)	female	male (%)	female	male (%)	female
n = 33	– (0.0%)	15	7 (77.8%)	2	4 (44.4%)	5

Table 10 Numbers, sex and provenance of juveniles (chicks) of *Eulipoa wallacei* in the collections of four Natural History Museums, based on a world wide inventory. See Table 8.

collection	total number of chicks	number of sexed chicks	number of male chicks	provenance
MZB Bogor	1	1	1	Buru[1]
NMR Rotterdam	13	13	6	Haruku[2]
RMNH Leiden	5	2	2	Halmahera[3], Ambon
USNM Washington	2	2	1	Halmahera[4]
totals	21	18	10 (55.6%)	

1 Wa'Kasi nesting ground.

2 found dead by Heij at the surface or in the soil of the Tanjung Maleo nesting grounds.

3 males are from the Galela nesting grounds, specimens with unknown sex are from Halmahera (with no more precise locality) and Ambon.

4 Pasir Putih village near Galela nesting grounds.

Food

Hardly anything is known of the food choise of *Eulipoa wallacei*. Siebers (1930) noticed that a newly hatched chick kept in captivity ate the insects he offered. Toxopeus (1922) and Siebers (1930) mentioned that five adult female specimens (carrying a mature egg) had only a small lump of green coloured sand in the stomach. Section on seven adult females, found dead at Tanjung Maleo during this study (now in the collection of the Natural History Museum Rotterdam, see Table 8), revealed that all but one had the stomach empty. One specimen (NMR 9997-00265) had a few hard seeds (2 x 2 mm) and the remains of scarab-beetles (Coleoptera: Scarabaeidae) and ants (Hymenoptera: Formicidae) in the stomach. The omnivorous food choise as supposed by Jones et al. (1995) could thus be confirmed.

We never actually observed *Eulipoa* to forage at the nesting grounds or in the surrounding forest. Remnants of termite nests found regulary below trees where the birds generally arrive and reside before they start their egg-laying activities, indicate that they do feed on termites. We have, however, no proof.

5 BURROWS

Most of the burrows at Tanjung Maleo are dug on the four fields that consist of fine white silicaceous sand and that are devoid of any vegetation. A small percentage (< 5%) is dug on the bordering beach, in the forest surrounding the fields and in sandy spots on the graveyard, sometimes even in the graves themselves. The four fields have a similar soil (sand) structure, although field 4 is situated about 20 cm higher and as a consequence, measured over a year, the soil is dryer.

Size

Direct observations already suggested that the surface size of the opening and the depth of the burrow depend on the humidity and the related structure of the soil. Often the colour of the soil, thrown up from the burrow, indicates the depth at which the egg has been laid. The sand at a depth of 100 cm is noticeably dryer and therefore of a much lighter colour. To quantify the difference in laying-depth, burrows were measured both in the dry season and in the rainy season during the early morning hours before the collecting of eggs had started as well as during the collecting activities. The length and width of the entrance was noted as well as the depth of the tunnel that leads to the spot where the egg has been laid. Two depths were measured: (1) 'burrow-depth': the depth at which the bird has left the burrow (with sand thrown and fallen in) and, (2) 'egg-depth': the depth at which the egg has been laid, measured after the egg has been unearthed (Fig. 17). The angle at which the birds dig their burrows was estimated by eye and appeared to be very constant at 45º in both dry and wet circumstances. Table 11 gives the results of the measurements. A clear difference exists between the dry season and the rainy season. In the rainy season the eggs are laid at an average depth of 79 cm (Type 1A, Fig. 17), which is over 30 cm deeper than during the dry season (Type 1B, Fig. 17). Schönwetter (1961) mentioned a general average depth of 60-75 cm. Also the dimensions of the burrow differ considerably. Especially during the dry season the surface of the opening of the tunnel can be extremely large due to inflowing sand (Type 1B, Fig 18). During the rainy season, the humid soil has a firm structure and as a consequence the burrow-opening is just wide enough for the bird to pass (Type 1A, Fig. 19). Apart from these seasonal differences in the average laying-depth, which appear to be adaptive to both humidity and temperature of the soil (see below), the range of measurements also points at the ability of the bird to adapt to specific nightly circumstances like clearness (full moon/new moon, cloudy/clear). For example on clear nights and in humid soil the eggs appear to be laid deeply into the ground, whereas on dark nights in dry soil the eggs are laid less deeply and sometimes the burrows cannot even be found (Table 12). Disturbance, especially when repeated during the course of the night, also influences the laying-depth.

Burrow types

All burrows are dug at an angle of about 45º and enter the soil in a straight line. Once the bird has reached a certain depth the egg is laid at the end of the tunnel (Type 1A and 1B, Fig. 17) or the bird diverts and continues to dig horizontally (every direction is possible) and lays the egg at the end of the horizontal tunnel (Type 2, Fig. 20). Normally, the bird then leaves the burrow through the same tunnel. Burrow-type 2 is mostly (not exclusively) found during the

Table 11 Dimension in cm (surface in cm ^{2}) of the burrow and laying depth during both the rainy and the dry season (n = number of burrows measured, range between brackets). See also Fig 17.

season	length	width	surface	burrow-depth	egg-depth	n
rainy	23(10-38)	15(10-25)	345(100-950)	44(25-90)	79(60-125)	201
dry	62(25-120)	48(20-90)	2976(500-10800)	28(10-65)	48(30-65)	228

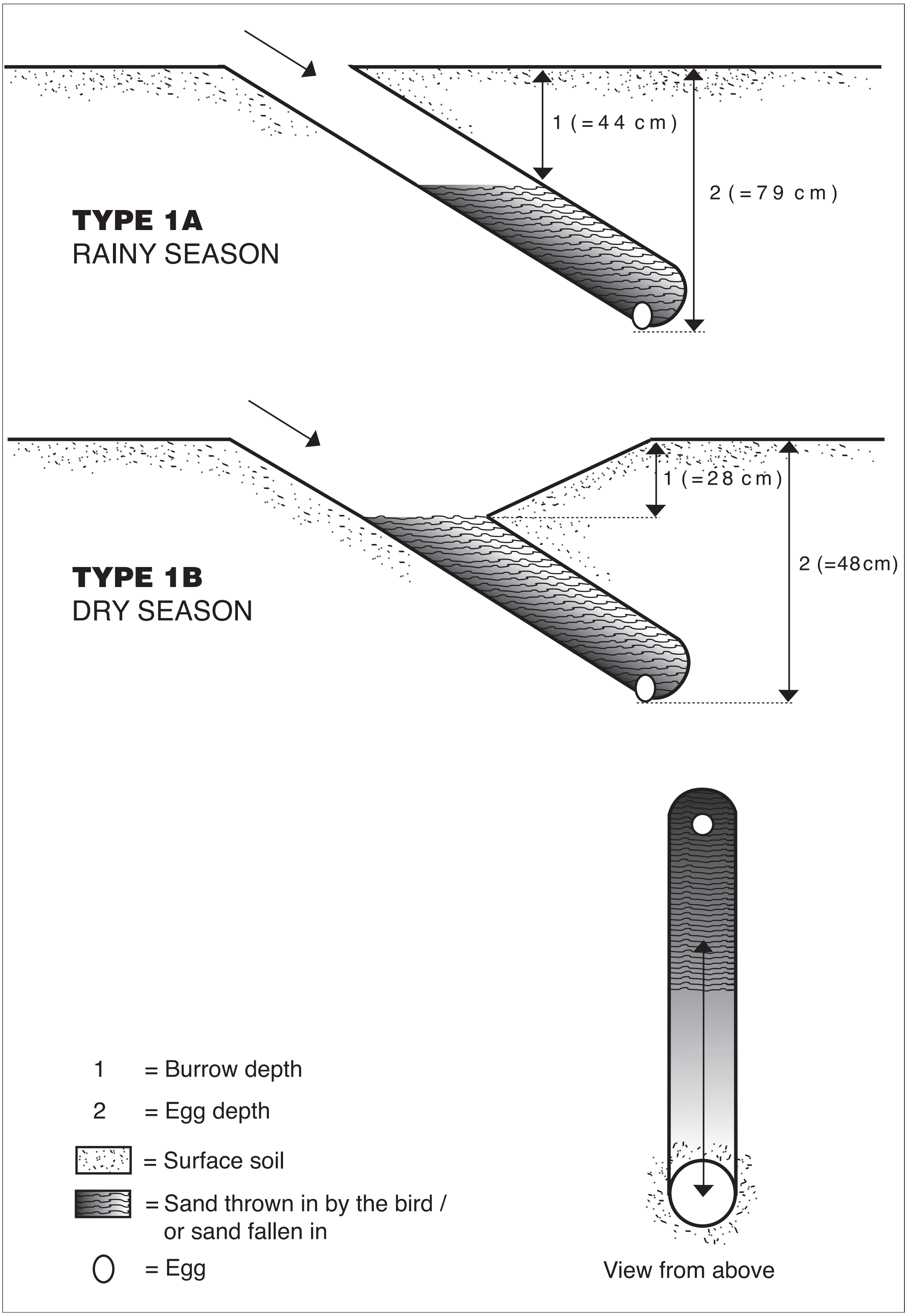

Figure 17 Burrow type 1: the most common type at Tanjung Maleo. The bird lays at the end of the tunnel. [illustration: Jaap van Leeuwen Design]

Table 12 Matr ix showing relative egg-laying depths at Tanjung Maleo under diff erent soil conditions and clearness situations.

situation	dry	humid
clear	+	++
dark	--	-

(++ = deepest; + = deep; - less deep; -- = minimum depth)

Figure 18 A typical dry season burrow. [photo: C.J. Heij]

rainy season and both egg-depth and burrow depth are the same as for burrow-type 1A. Occasionally, we observed a third type of burrow during the rainy season in humid soil: after digging in a straight line at the normal angle to a depth of 80 to 100 cm, the bird diverts and continues to dig horizonally (like in Type 2) for at least one metre. Somewhere on the horizontal track the egg is laid. Then the bird perpendiculary digs its way up. Just under the surface she stops digging and remains sitting like newly hatched chicks do, forming a cavity in the soil ('internal exit-cavity'). After a while (1-5 minutes) she emerges, leaving a small exit-burrow, which has a form similar to that of a newly fledged chick, but is lar ger (Type 3, Fig. 21, Table 13). Burrows of type 3 are very misleading to predators, even to humans.

Mostly during dark nights, existing burrows may be used by more than one bird, although in cases like that the second bird only uses the entrance and digs her own tunnel. This kind of laying-strategy annoys the egg-collectors. They respond by marking single-entry burrows with fresh twigs, which prevents a multiple use of the burrow (see: chapter 3, Fig. 7).

Figure 19 Typical rainy season burrows. *Eulipoa* footprints are clearly visible. [photo: C.J. Heij]

Table 13 Average dimensions of the exit of burrow-type 3 in cm (surface in cm^2), range between brackets (n = number of burrows measured). See also Fig. 21.

	length	width	surface	n
exit-opening (A)	14(9-20)	12(11-19)	168(70-460)	28
internal-cavity (B)	19(13-25)	18(14-25)	342(182-420)	28

Use of the fields

In the morning after a clear night the nesting grounds resemble a crater landscape or an exploded mine field. All over the field there are clusters of burrows. The entire field seems to have been used. However, when the amount of displaced sand per (collected) egg is calculated, it appears that the birds have only used part of the available surface for egg-laying purposes. In order to ascertain this, the average amount of displaced soil per egg was calculated (from Table 11) and compared with the total available quantity of soil at Field 4 (considering the maximum laying depth of 1.25 m). On the average a single bird displaces 40 dm^3 sand for the laying of an egg (burrows which do not contain eggs [mockpits] have been included). On Field 4, calculated over a year, all egg-laying birds combined appear to have displaced 57.6% of the available soil.

As was noted earlier (see: chapter 3), the burrows are refilled and the fields are completely flattened each morning by the local people after the eggs have been collected. Tanjung Maleo is the only *Eulipoa* nesting ground where this is done. It is unknown if or how the flattened nesting grounds influence the behaviour of the birds. Perhaps it explains the high number of birds using a relative small area (Heij 1995a). Nesting grounds at which many burrows are still visible, might trigger the birds to lay elsewhere. Further study is needed to test this hypothesis.

Clusters of burrows

As became clear after nightly observations at the nesting grounds, the birds tend to dig their burrows in groups during both the dry and the rainy season. Every morning on each field the burrows were found in a number of clusters (Fig. 22). On Field 4, which at our request suffered no or very few nightly disturbances, the clustering pattern was studied in detail. Clusters appeared to be evenly spread over the field. Based on 36 early-morning counts, the average number of clusters was 4 (range 2-6) and the average number of burrows per cluster was 8.5 (range 4-13).

Number of eggs per burrow

Not all burrows appeared to contain eggs (‘mockpits’) and not all eggs were found by the collectors. In order to quantify this, 162 early-morning counts of the total number of burrows on all four fields were made and compared with the total harvest (number of eggs) of the day: an average of 1 egg per 2.5 burrow was collected. In Halmahera (Gamkonora and Galela nesting grounds) 1 egg per 4 or 5 burrows was being collected in the period 30 January - 3 February 1995. This difference might be caused by the total absence of nightly human disturbance at the Gamkonora and Galela nesting grounds. At Tanjung Maleo disturbances occur frequently, which prevents the birds from digging all night and forces them to lay their eggs rather in a hurry at dawn (see: chapter 4). Occasionally, during dark nights, two or three eggs were found in (what appears to be) one burrow, although closer examination revealed that, in such cases, birds indeed used one entrance but had dug separate tunnels.

Temperature in the burrow

Two abiotic factors are essential for the development of the embryo: temperature and humidity. The temperature of the soil could be monitored permanently with sensors placed at the surface (0 cm) and at depths of 20, 40 and 80 cm in a part of field 2 that was used for

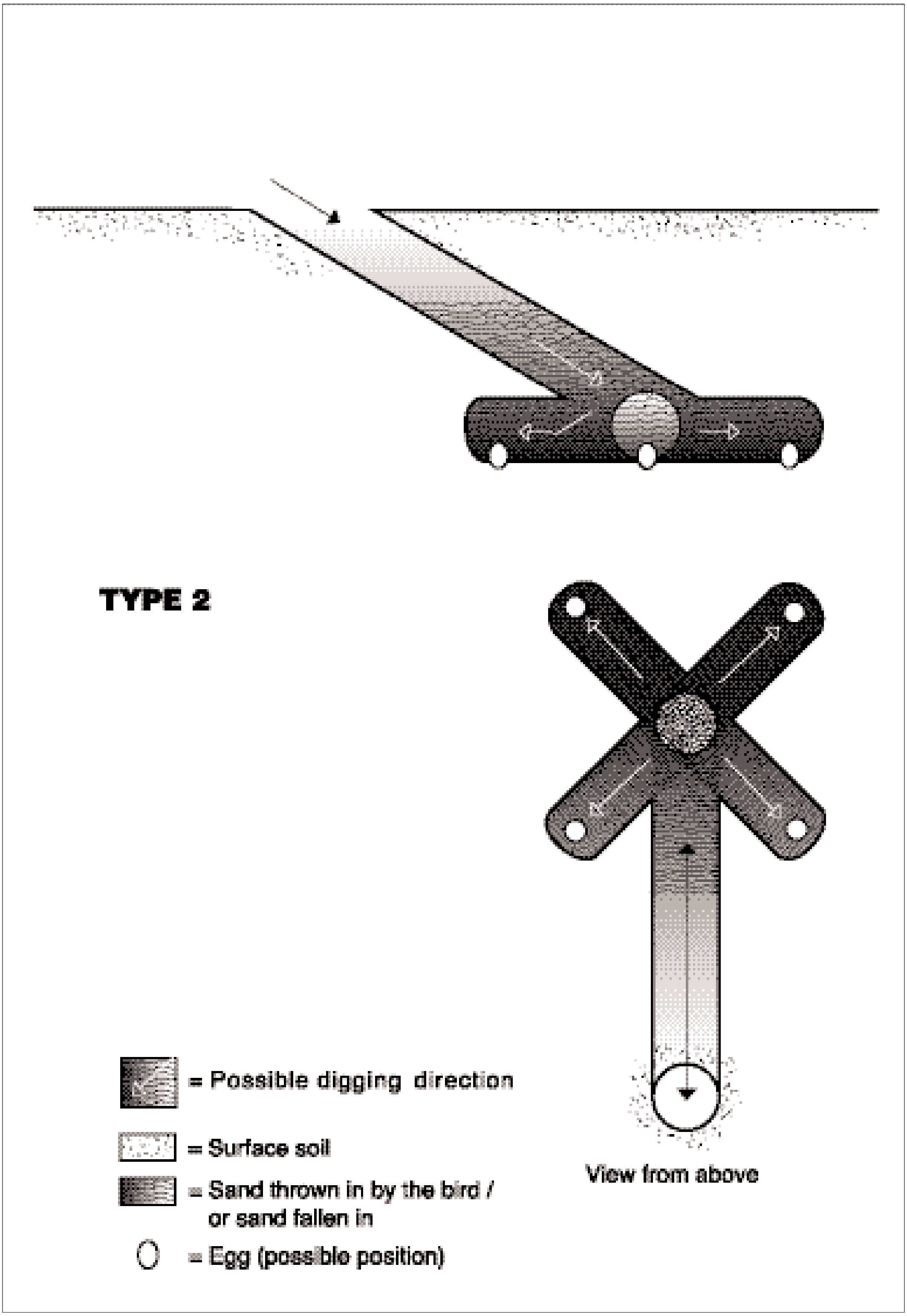

Figure 20 Burrow type 2: commonly found at Tanjung Maleo. At the end of the tunnel the bird contin ues to dig horizontally, in every possible direction and subsequently lays her egg at the end of the hor izontal track. [illustration: Jaap van Leeuwen Design]

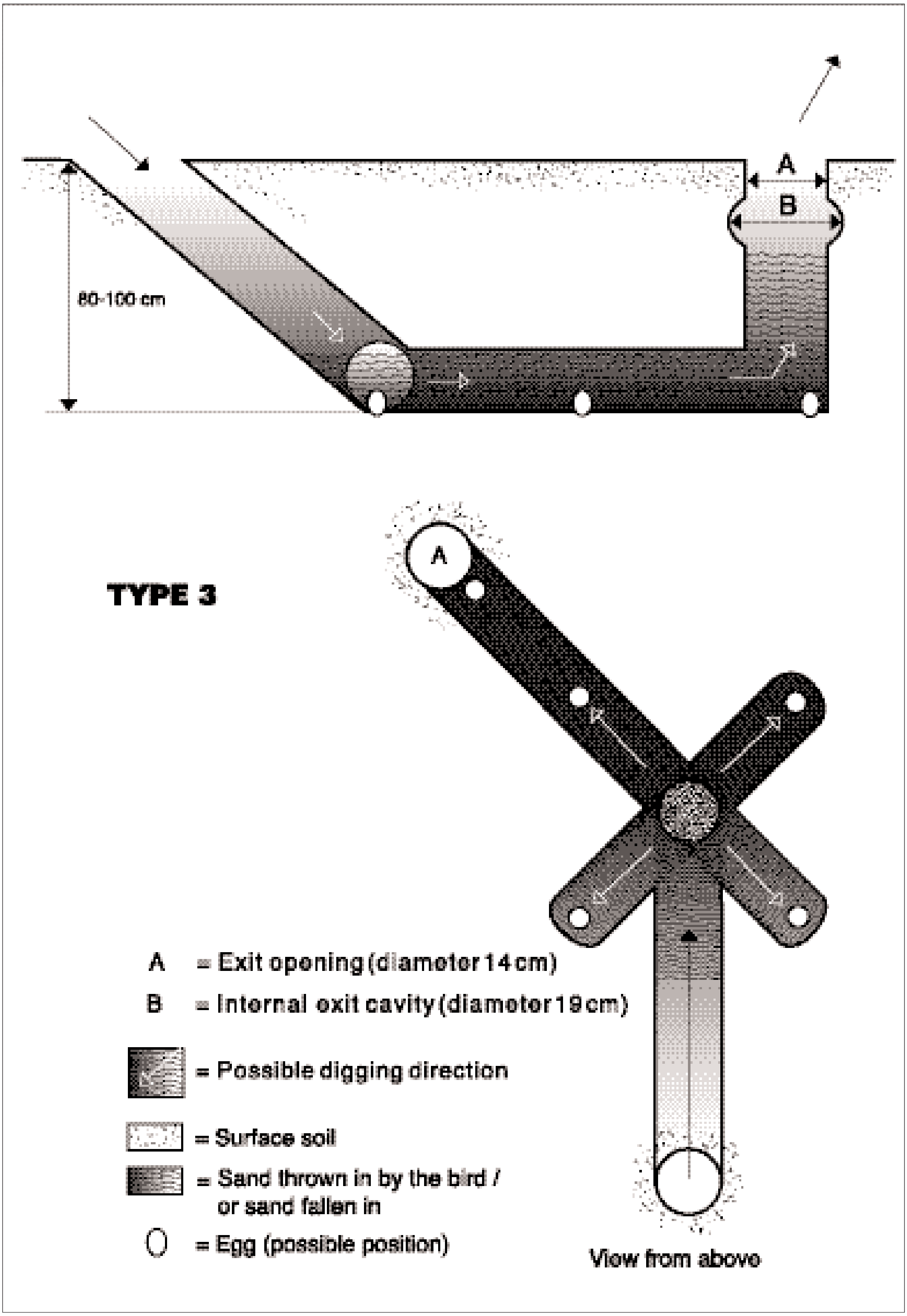

Figure 21 Burrow type 3: occasionally encountered at Tanjung Maleo. For explanation see text.
[illustration: Jaap van Leeuwen Design]

Figure 22 A typical cluster of *Eulipoa* burrows at Tanjung Maleo. [photo: C.J. Heij]

incubation-experiments and that was protected for this reason by a wooden frame (105 x 90 x 25 cm) covered with wire netting (Fig. 23). Readings were done almost daily during the 1994/1995 study period at three standard moments: 06.30-07.30 a.m., 12.30-13.30 p.m. and 18.00-19.00 p.m. The shortest continuously monitored period was 68 days. The total number of temperature readings at each of the four depths was 288 in the rainy season and 255 in the dry season. Table 14 gives the results and in Figure 24 the average soil temperature is plotted against a 24 hour time scale.

The surface-temperature of the soil is between 3.5 and 4.0 ºC lower during the rainy season compared to the dry season. The 24 hour temperature-curve shows that the surface has accumulated most of the heat at 18.00 p.m. and that at 06.00 a.m. the temperature is lowest (Fig. 24). This pattern, together with the difference between both seasons, is predictable and in accordance with the ambient air-temperature (Table 2). At a depth of 20 cm the difference in temperature is even greater: an average of 4.2 - 5.5ºC higher during the dry season (Table 14). During the rainy season the average temperature at 20 cm is rather low and very constant (26.9-27.3ºC) throughout day and night. This is probably effected by water that saturates the soil and subdues a high amplitude. At greater depth temperatures are higher, and differences between both seasons are slight. During the dry season there is almost no difference in temperature between depths of 40 and 80 cm (the averages range between 32.8/32.9 and 35.0ºC at both depths), although during the rainy season the average temperature is 0.7 - 1.8ºC higher at a depth of 80 cm. At 40 cm the rainy season

Figure 23 The installation of the wooden frames used for incubation experiments and temperature readings at Tanjung Maleo, field 2. [photo: A.G. Heij-Ruuls]

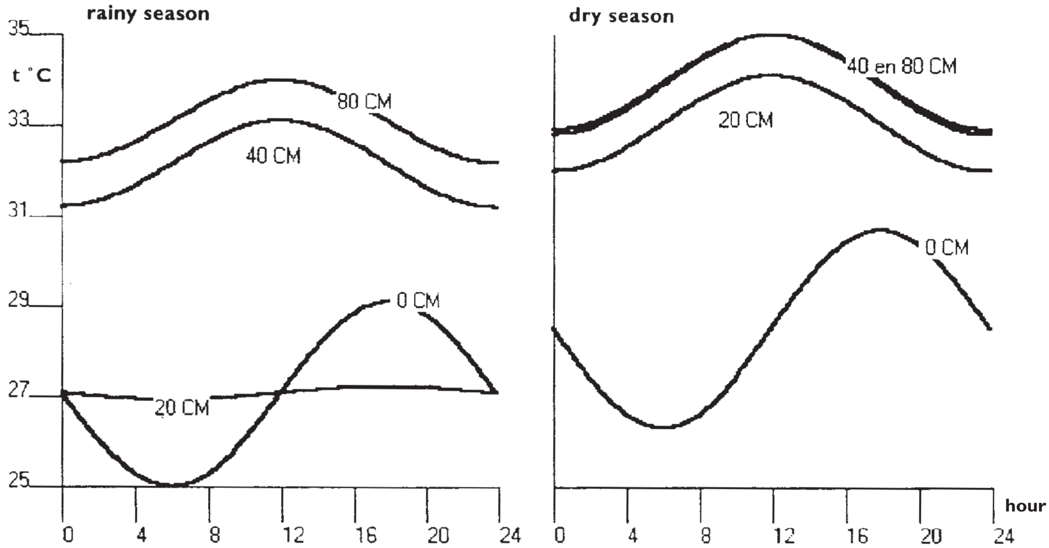

Figure 24 The 24 hour path of the average soil temperature, measured at the surface (0 cm) and at different depths (20, 40 and 80 cm) at field 2, Tanjung Maleo, during the rainy season and the dry season. Measurements were taken daily at standard times during the period July 1994 - June 1995.

soil-temperature averages from 31.2 to 33.1ºC. Knowing these temperature data, the laying-depth during the rainy season is expected as no less than 40 cm to be energetically profitable as the eggs of burrow-nesting megapode species are usually incubated at temperatures of 32-35ºC (see: Dekker 1988), with 34ºC being the optimal temperature (Jones et al. 1995). Such appeared to be the case: during the rainy season the birds lay their eggs at greater depth (average 79 cm, range 60-125 cm, Table 11), where the average temperature ranges between 32.9 and 34.7ºC (Table 14). During the dry season the eggs are laid at a considerably lesser depth: 48 cm (range 30-65 cm), though still at average temperatures ranging from 32.9 to 35.0ºC. As the soil temperature is equal at depths of 40 and 80 cm during the dry season (Fig. 24, see above) there is apparently no need to bury eggs deeper, indicating that the laying-depth is adapted to the temperature of the soil. However, incubation-experiments executed during both the dry and the rainy season (see: chapter 6) showed that freshly laid eggs, reburied at depths of 20, 40, 60 and 80 cm had an equal chance to hatch. The duration of the incubation period – likely to be related to soil temperature (Jones et al. 1995) – appeared to vary considerably and was longer during the rainy season (see: chapter 6). As was noted earlier, laying-depth is also influenced by the clearness of the night and the occurrence of prolonged nightly disturbances.

Humidity in the burrow

To establish the humidity of the soil of the Tanjung Maleo nesting grounds, sand samples of 300 g each, were taken from depths of 0 cm (surface), 20 cm, 50 cm and 100 cm. Per depth three samples were taken, a total of 48 samples evenly spread over the dry season and the rainy season. After drying in the sun, the water percentage was calculated as follows:

$$\frac{(Mw - Md) \times 100}{Mw}$$

Mw = wet mass;
Md = dry mass of the soil sample.

It appeared during our studies that drying in the sun was not sufficient to completely remove the water. Therefore the samples were once more dried for 24 hours in an oven at a temperature of 60ºC, after which the percentage of water was again calculated. Table 15 gives the results.

Table 14 Average temperature of the soil at different depths in field 2 of the Tanjung Maleo nesting grounds during the rainy and the dry season (ranges between brackets; n = total number of temperature readings at each of the four depths).

depth (cm)	time	rainy season (n=288) temp. °C	dry season (n=255) temp. °C
0	06:30 - 07:30	25.0 (24.0 - 28.3)	28.5 (26.1 - 35.8)
	12:30 - 13:30	27.7 (24.9 - 35.3)	31.7 (30.0 - 36.9)
	18:00 - 19:00	29.1 (22.8 - 38.4)	32.9 (28.0 - 45.4)
20	06:30 - 07:30	27.1 (25.0 - 29.1)	32.0 (29.3 -35.6)
	12:30 - 13:30	26.9 (24.5 - 29.4)	34.1 (30.1 - 39.9)
	18:00 - 19:00	27.3 (25.2 - 29.1)	32.8 (30.0 - 37.1)
40	06:30 - 07:30	31.2 (30.0 - 35.2)	32.9 (29.3 - 35.8)
	12:30 - 13:30	33.1 (31.6 - 38.5)	35.0 (30.4 - 39.5)
	18:00 - 19:00	32.2 (30.1 - 36.2)	33.2 (30.3 - 35.9)
80	06:30 - 07:30	33.0 (30.0 - 34.9)	32.8 (30.2 - 35.6)
	12:30 - 13:30	34.7 (31.1 - 37.4)	35.0 (32.5 - 39.6)
	18:00 - 19:00	32.9 (29.9 - 35.5)	33.6 (30.2 - 36.7)

The humidity in the soil proved to be very important for the development of the egg. Laboratory-experiments we conducted both at Kailolo and in Bogor, proved that at low (< 3%) humidity of the soil an embryo could develop to a mature chick, but would eventually dry up totally, not being able to hatch. The minimum water content of the soil allowing eggs to develop and chicks to hatch is, however, not known. In burrows of *Macrocephalon maleo*, Dekker (1988) found a moisture content at different nesting grounds that varied from 1.6 - 45%, although in one monitored burrow the range was 6.3 - 11.6%. Upon digging we noted that, especially when the surface is cooler than the underlying soil, a warm vapour escapes from the sample, showing the humidity of the sand. Table 15 gives the percentage of water during dry and wet season at various depths. Moisture content increases with the depth, the highest water-percentage was found at 100 cm in both seasons: 4.9 % during the rainy season, 5.5% during the dry season. In general the humidity of the soil was higher during the dry season, the difference is however slight: 3.4% rainy season and 3.8% dry season. This is rather surprising and might be due to accumulation of water in the course of the rainy season, being measured at the start of the dry season. The surface soil was, however, much dryer during the dry season (Table 15).

Tabel 15 Water contents (humidity), established by both drying in the sun and in an oven at 60°C, of the soil at Tanjung Maleo at various depths during the dry season and the rainy season.

depth/cm	dry season		rainy season	
	water contents in samples of 300 g		water contents in samples of 300 g	
	g	%	g	%
0	1.5	0.5	6.2	2.1
20	12.6	4.2	10.4	3.5
50	14.8	4.9	9.9	3.3
100	16.5	5.5	14.8	4.9
depths combined	45.4	3.8	41.3	3.4

6 EGGS

Here we will report on weight, measurements, colour, contents and temperature of the *Eulipoa* egg. Data were taken on site, immediately after the eggs had been unearthed (Fig. 25). The results of two field-experiments are also given. It concerns experiments to establish the duration of the incubation period and to test the ability of hard-set eggs and freshly laid eggs to hatch after being replaced and reburied.

Figure 25 An early morning routine at Tanjung Maleo: the first author weighing eggs. On the background some burrows are clearly visible. [photo: P. Rehatta]

Size

Measurements of eggs are given in Table 16. The form of the egg is quantified by dividing length by width (L/W). The higher the L/W ratio, the longer the egg (Schönwetter 1985).

Table 16 Measurements (in mm) of *Eulipoa* eggs collected at Tanjung Maleo (ranges between brackets). Data collected year round.

length	width	l/w ratio	n
78.1 (74.1-85.5)	48.9 (42.0-51.8)	1.6	299

An average egg measured 78.1 x 48.9 mm, with the L/W ratio being 1.6. Dekker's sample of 19 eggs from Haruku measured 80.0 x 49.0 mm (Dekker et al. 1995; Jones et al. 1995). Our sample of 299 eggs ends up having slightly lower averages, but shows a wider range of extremes, the difference between the lowest and higest values being about 10 mm (Table 16).

Weight

The average weight of the *Eulipoa* egg at Tanjung Maleo is 101.7 g. Eggs being laid during the rainy season are on average 2.7 g heavier than those from the dry season (Table 17). While computing these data, eggs laid during the full-moon period appeared to be the heaviest, though more data is needed to to provide conclusive evidence on this matter. The average weight we calculated from a sample of 433 eggs is almost 5 g lower than the weight given by Jones et al. (1995): 106.4 g based on a sample of 42 collected in October at Tanjung Maleo. This difference is influenced by the presence of two extremely light eggs (each 59 g) in our sample, an inevitable result of the large number of eggs we weighed. Another sample of 57 eggs from January/ February listed by Dekker et al. (1995) had an average weight of 102.8 g and comes much closer to our values. West et al. (1981) had clearly been sent a batch of small eggs (average 94.1 g; n=20). Eggs we collected at other nesting

Table 17 Weight (in g) of freshly laid eggs of *Eulipoa* at Tanjung Maleo.

	average weight	(range)	n
rainy season	103.6	(86 - 120)	130
dry season	100.9[1]	(59 - 124)	303
year round	101.7	(59 - 124)	433

[1] The average weight for eggs collected during the dry season was incorrectly printed in the preliminary report of this study (Heij 1995a). It should read 100.9 g instead of 109 g. The conclusion that 'eggs are less heavy during the wet season' should therefore be 'eggs are less heavy during the dry season'.

Table 18 Average weight of the egg relative to the average weight of the body in 29 captured *Eulipoa* females at Tanjung Maleo (ranges between brackets).

body weight without egg	egg weight	relative egg weight	n
517.5 g (456-605)	105.8 g (95-119)	20.5 % (18.0-22.2)	29

grounds weighed 103 g (90-120 g, Buru, September, n=19); 103 g (98-105 g, Seram, November, n=9); 110 g (105-115 g, Kasa, November, n=2) and 100 g (95-103 g, Halmahera, February, n=4). The Halmahera sample was biased, as the largest eggs had already been sold. To avoid this, eggs should always be weighed at the nesting sites, directly after unearthing, before the sale has started.

Relative weight

The weight of the egg relative to the body weight of the female was established by pressing the egg out of the body of 29 captured birds and weighing both egg and bird (Table 18). The average weight of the birds just after extracting the egg was 517.5 g, the egg taking account of 20.5 % of the body weight. Relative egg weight measured from three females caught at Tanjung Maleo as given by Dekker et al. (1995) and Jones et al. (1995) ranged between 18.4 and 20.6%.

Colour

There is a marked difference in the colour of freshly laid and hard-set eggs. The longer an egg has been in the soil, the more the colour deepens to rusty brown and chocolate colours (PLATE III). The coloured outer layer (a kind of powder) loosens after some time so that a patchy pattern emerges: the underlaying white shell becomes clearly visible. In order to ascertain the colour of the egg, Smithe (1975) was used as a standard. Freshly laid eggs are coloured light flesh to dark salmon (PLATE IV) (Smithe Guide notation: R. 7.0/6.0; YR 7.0/6.0; Swatch notation 0.8 YR 6.95/5.9; YR 6.90/6.0). Hard-set eggs are, according to this method, antique brown (Smithe Guide notation: 7.5 YR 4.5/5.0; Swatch notation 6.9 YR 4.40/5.6).

Yolk percentage

Megapode eggs contain an extremely large amount of yolk in comparison with the eggs of other birds, ranging from 48 to 69 % of the weight of the egg (Jones et al. 1995). In order to ascertain the yolk percentage for *Eulipoa wallacei*, a total of 50 eggs were weighed and boiled (PLATE V). Afterwards, the yolk, the eggwhite (albumen) and shell were weighed separately, so that the percentage per item could be calculated (Table 19). During boiling the eggs became, on average, three grammes (2.9%) heavier through water absorption. This water dissipated when the egg was dissected and was of no influence to the results. The average yolk percentage appeared to be 66.3. Jones et al. (1995) listed 65-67% for the species, though no sample size was given. Nine eggs analysed by Dekker et al. (1995) had an average yolk percentage of 67.6 (range 65.0-71.4%).

Table 19 Average yolk percentage in 50 eggs of *Eulipoa wallacei* collected at Tanjung Maleo in November 1994 (during full-moon), and the average weight of the three major components (weights in g, range between brackets). The average yolk percentage was calculated from the total weight of the sample (50 eggs): 5355 (egg) - 440.2 (shell) = 4914.8 [3256.6 yolk = 66.26%].

egg weight (not boiled)[1]	shell weight[2]	albumen weight	yolk weight	% yolk	n
107.1 (99-124)	8.8 (7.0-11.0)	32.2 (25.5-39.0)	66.7 (56.0-81.0)	66.3 %	50

1 freshly boiled eggs weighed 110.3 (99-138), not used to calculate yolk percentage

2 average thickness of the shell is 0.07 mm (0.04-0.12 mm); the heaviest eggs have the thinnest shell.

Table 20 Temperature just around the egg during incubation and at similar depth in the soil at 55 cm in the dry season (79 days, 237 readings) and the rainy season (81 days, 243 readings) at Tanjung Maleo.

	dry season		rainy season	
time	temperature around egg	temperature at similar depth	temperature around egg	temperature at similar depth
06:30 - 07:30	32.5°C	31.4°C	31.9°C	31.5°C
12:30 - 13:30	33.3°C	32.3°C	33.7°C	33.2°C
18:00 - 19:00	32.1°C	31.2°C	31.9°C	32.5°C
average	32.6°C	31.6°C	32.5°C	32.4°C

Temperature
Just after the egg has been laid, it has a temperature of 41.5ºC, equal to the body temperature of the bird (measured in four cases). Subsequently, the temperature of the egg was measured constantly (next to the shell) during incubation at a depth of 55 cm for 79 days in the dry season and 81 days in the rainy season. Besides, the temperature of the soil at the same depth and at the same site was monitored (Table 20). During the dry season the temperature of the developing egg was, on average, 1ºC higher (32.6ºC) than the temperature of the soil (31.6ºC) at the same depth. During the rainy season this difference was just 0.1ºC: egg 32.5ºC, soil 32.4ºC (Table 20), but still the developing egg does produce measurable heat. Compared to the average temperature of 35-36ºC at which birds eggs are generally incubated (Kendeigh et al. 1977), these temperatures are rather low. Artificially incubated eggs of the malleefowl *Leipoa ocellata* (a mound-breeding megapode) had the highest chance of hatching at 34ºC, but the embryos survived a temperature range of 28-38ºC (Jones et al. 1995).

Incubation period: observations and experiments
Methods - The duration of the incubation period (i.e. the amount of time between the laying of the egg and the fledging of the chick) was monitored in the field by both incidental observations and experiments. Freshly laid eggs were carefully reburied in their original position and depth, and also in different positions and at different depths. In the latter way it was established whether a change in the original position of the egg has a negative influence on the development, as was argued by several authors (Fleay 1937, Dekker 1990, Jones et al. 1995). For these experiments, five protective frames were placed at the nesting grounds. These wooden frames, 105 cm long, 90 cm wide, 25 cm high, were sunk to a depth of 10 cm in the soil in the middle of field 2 (Fig. 23). Eggs were reburied within the boundaries of the frames. The frame could be covered with a net to prevent predation and to prevent unwanted eggs to be laid. The moment of fledging could easily be established by the appearance of little round cavities from which the chicks had emerged (Fig. 26) and/or chicks trapped in the frame. During the dry season these emergence craters are less conspicuous due to the loose structure

Figure 26 In the breeding experiments the moment of fledging could easily be established by the appearance of little round craters in the soil from where the chicks had emerged. [photo: C.J. Heij]

of the dry soil (see: chapter 7). In addition to these experiments to establish the duration of the incubation period, it was also investigated whether already developed (hard-set) eggs (that are normally destroyed by the local collectors), which we reburied in a different position as laid by the bird, had any chance of further development. Laboratory experiments were carried out both in Kailolo and Bogor.

Laboratory results - In 75% (n=8) of the eggs placed in sand-filled glass jars and kept on a kitchen shelf in Kailolo, an embryo came to full developement. However, after 104 days the chicks had died since they had not been able to break the egg-membranes. Of 15 freshly laid eggs placed in an incubator at the Bogor laboratory, where the temperature was kept between 31.5ºC - 32.0ºC at a relative humidity of 70% , all the embryo's died after a few weeks. In the incubator at the same conditions, 10 already hard-set eggs containing embryo's, produced three hatchlings which lived for respectively 5, 14 and 15 days. West et al. (1981) also experimented with artificial incubation of *Eulipoa*-eggs: their hatchlings also died very soon. Valentijn (1726) already indicated that this bird cannot be tamed or kept in captivity.

Table 21 Average duration of the incubation period of *Eulipoa wallacei* at the Tanjung Maleo nesting grounds (extremes between brackets; n = number of monitored eggs). The incubation period includes the time needed for the chick to reach the surface.

	incubation period in days	n
year round	74.2 (49-99)	63
dry season	73.2 (49-99)	53
rainy season	79.6 (70-85)	10

Field observation - On 23 August 1994, a freshly laid egg was left in the burrow by a local collector because the tunnel ran under the concrete edge of a human grave and the collector feared 'revenge'. The burrow was refilled and patted and the date was written on the grave with a felt pen. During the night of 28/29 November 1994 a small round hole in the grave indicated that the chick had hatched and had fledged. The incubation period took 98 days.

Results of field experiments - The average duration of the incubation period throughout the year, based on the monitoring of 63 freshly laid eggs, is 74.2 days. This includes the time it takes the chick to reach the surface (1-4 days, see chapter 7). During the dry season it is 73.2 days and during the rainy season it takes an average of 79.6 days before a chick emerges from the soil (Table 21). Three eggs had an extremely long incubation period. They were from a sample of five freshly laid eggs that were reburied at the usual protected experiment-site. After 92 days no chick had appeared so the eggs were unearthed and checked. All five eggs appeared to contain embryo's and were in good condition. They were subsequently buried again at the same site and depth (55 cm) and kept under constant surveillance. After an other 72 days two healthy chicks emerged from the soil: their total incubation period amounted 164 days, more than twice the average. It should be noted that these two hatched eggs are not included in the sample that resulted in the average incubation period of 74.2 days.

Tables 22 & 23 give the results of the reburying experiments of freshly laid eggs. Of the 68 eggs reburied at various depths, 92.6% produced hatchlings (that fledged). The actual depth at which the egg had been reburied (20-80 cm),

Table 22 Results of reburying experiments at different depths with a total of 68 freshly laid *Eulipoa* eggs carried out at Tanjung Maleo (eggs reburied in their original position).

depth	number of reburied eggs	number hatched	%
20 cm	19	17	89.5
40 cm	37	35	94.6
60 cm	5	5	100
80 cm	7	6	85.7
totals	68	63	92.6

Table 23 Results of several types of reburying experiments with freshly laid *Eulipoa* eggs carried out at the Tanjung Maleo nesting grounds.

type of experiment	number of reburied eggs	number hatched	%
original position (year round)	68	63	92.6
original position (dry season)	57	53	91.4
original position (rainy season)	11	10	90.9
changed position (upside down)	10	10	100
changed position (horizontally)	10	10	100

did not seem to be of any significance to the results (Table 22). The season and the position in which the eggs were reburied did not influence this result either (Table 23): even eggs that were reburied in a reversed position (upside down or horizontally) all hatched.

Discussion - Compared to the (few) data on the duration of incubation in other megapode species, summarized by Jones et al. (1995), the average incubation period of *Eulipoa* eggs at Tanjung Maleo is within the range of absolute extremes (44-99 days) listed for the family (mound breeders and burrow nesters combined). The normal range is, however , 49-65 days. For the burrow nesting *Megapodius pritchardii*, *M. eremita* and *Macrocephalon maleo* the range is 47-67, 42-70 and 62-85 days respectively . One egg of *M. cummingii* (also a burrow-nester) hatched after 63 days (Jones et al. 1995). The two *Eulipoa*-eggs that hatched after 164 days (see above) had the longest incubation period ever recorded for a megapode, and indicate the extreme flexibily of the species' breeding-biology. This flexibility is also shown by the 100% hatching-rate of eggs that were reburied upside down and horizontally (*contra* Dekker 1990) and by the burrow and egg temperatures that were, at Tanjung Maleo, - on average - below the optimal incubation temperature of 34ºC as given by Jones et al. (1995).

Reburying hard-set eggs

During collecting activities, eggs that had been in the soil for a longer period and consequently were in various stages of development, are regulary unearthed. They are easily recognised by their darker colour and the loose and partially missing outer skin. In case of doubt they are held up against the light. These hard-set eggs must have been overlooked during previous collecting activities and - as only freshly laid egg have commercial value - are either destroyed by the collectors, or , in case of lightly hard-set eggs, are taken home and fried. Occasionally hard-set eggs are injected with poison and left out in the open as a bait to kill egg-predators like monitor lizards (Fig. 5).

Methods - During our presence at the Tanjung Maleo nesting grounds we tried to prevent the unearthed eggs from being destroyed. A total of 202 hard-set eggs could be rescued and were reburied at safe locations at the edges of the fields at depths between 15 and 50 cm. The exact location of each egg was indicated with a plastic label showing the reburying date (PLATE III). Reburying locations were checked daily as the eggs could hatch any moment. In case there was no indication of fledging 2.5 months after reburying, the location was excavated to check the fate of the egg. The remnants of the eggs clearly showed whether a chick had hatched or not: clean egg shells indicated an hatched egg (Fig. 27) whereas egg shells grown with roots of plants and with fungi (Fig. 28) indicated that the egg did not hatch; plants and fungi having used the egg contents as a rich substrate.

Results - These experiments resulted in 67.8% fledged chicks (n=202); 23.3% of the reburied eggs did not hatch and 8.9% of the eggs could not be checked since the labels got lost. During the first months when these experiments were carried out, the fledging-rate of reburied hard-set eggs was 50% (n=45). This rather low percentage was probably caused by the fact that the depth at which the eggs had been reburied (15-20 cm) was not favourable. Later on, the eggs were reburied at depths between 35 and 50 cm and the percentage that produced fledged chicks increased to 72.6 (n=157), whereas 16.0%

Figure 27 Unearthed remnants of a sucessfully hatched *Eulipoa* egg. [photo: C.J. Heij]

of the eggs did not hatch and 1 1.5% could not be retrieved due to lost labels. In contrast to these findings, the hatching-rate of reburied freshly-laid eggs was equal at depths between 20 and 80 cm (see above and Table 22).

In the laboratory-incubator, 33.3 % (n=10) of the hard-set eggs hatched, although the survival of the chicks in captivity was very low. Earlier attemps to experiment with artificial breeding of hard-set *Eulipoa* eggs (De Wiljes-Hissink 1953) failed, as on Ambon and Halmahera only freshly laid eggs were sold for consumption, and hard-set eggs were not available.

The positive results of the field-experiments with hard-set and freshly laid eggs give good prospects for reburying as a measure to increase the survival of the *Eulipoa* population. Although the local egg-collectors of Tanjung Maleo always seemed very enthousiastic when reburied hard-set eggs hatch, they are not motivated to keep hard-set eggs and only reburied them under our supervision. In general the local interest and insight in the survival of the species is totally absent (see also: chapter 3). We believe, however, that through guidance and education, the villagers of Kailolo can continue collecting eggs and still give *Eulipoa* a chance to survive (see: chapter 12).

Figure 28 Unearthed remnants of *Eulipoa* eggs that did not hatch: roots of plants and fungi used the egg contents as a substrate. [photo: C.J. Heij]

7 HATCHLINGS AND FLEDGLINGS

We define a 'hatchling' as an *Eulipoa* chick working its way out of the egg and up to the surface. Once at the surface and out in the open, we call it a 'fledgling'. A 'chick' refers to both hatchlings and fledglings. The term 'juvenile' is not used here, despite the fact that megapode fledglings already have a feathered (juvenile) plumage rather than a downy plumage. We regard birds having obtained a second generation of feathers through post-juvenile moult a few weeks after hatching (Jones et al. 1995), as true juveniles. Birds in that (immature) plumage were, however, not encountered during this study.

Hatching: breaking the egg shell

The behaviour of the *Eulipoa* chick during hatching is virtually unknown. Campbell (1903) mentioned that megapodes hatch by kicking their way out of the shell. Siebers (1930) considered the way the *Eulipoa* chick frees itself from the egg shell, to be an enigma. He noticed that the egg is surrounded by sand that - due to penetrating rain - is compressed and firm. So indeed it is quite a job for the chick just to emerge from the egg, let alone to struggle its way up to the surface. As megapodes are known to loose their egg-tooth before hatching (Del Hoyo et al. 1994, Jones et al. 1995) the chick has to push in order to break the egg shell (instead of picking). From dissection of 35 hard-set eggs in various stages of development (damaged during collecting-activities at Tanjung Maleo), we established that the chick looses its (vestigial) egg-tooth a few days before hatching. Both in the field and the laboratory we established from direct observations that at hatching the chick pushes violenty, creating a lengthwise crack in the shell (Fig. 29) after which the egg breaks open along the crack within a few minutes. We witnessed that if the egg shell does not immediately break completely (and the chick is not able to hatch), pulmonary respiration does not start, causing the chick to die. Unearthed eggs, showing the lengthwise crack, always contained a fully developed (dead) chick. In many cases, we observed these eggs, while still buried in the soil, to be invaded by ants (*Solenopsis* sp.) which had entered the egg through the crack and were scavenging on the chick. So, in case a chick, unable to free itsef from the egg shell, does not suffocate immediately, the ants surely will cause its death.

Figure 29 At the moment of hatching the *Eulipoa* egg shows a lengthwise crack. [photo: C.J. Heij]

The upward struggle

After breaking the egg shell (hatching), the chick struggles up to the surface, a journey of 30-125 cm (see chapter 5, Table 11). Immediately after hatching, while still deeply buried, the chick has a complete, feathered plumage although both the flight feathers and contour feathers are still packed in waxlike sheaths. During the upward struggle the sheaths gradually wear of f. While digging for eggs, the collectors accidentally came across chicks on their way to the surface. These 'premature' fledglings were released at the forest edge. Their condition, depending on the depth at which they were found, was generally bad. They were inactive, had their feathers still packed in sheaths (thus unable to fly), made squeaking noises and were soon to die. Dissection of these chicks (n=15) established the presence of a thick layer of subcutaneous fat on the breast, thighs and behind the coccyx. Their pectoral muscles were strongly developed and the presence of a lar ge provision of yolk was striking. Fledglings that had reached the surface on their own (n=17), however, appeared to have no subcutaneous fat, but still had a good amout of yolk in their yolk sac. The weight of chicks working their way up and the weight of those that had reached the surface differs accordingly (Table 24): 69.1 g while in the soil and 57.0 g when at the surface.

Table 24 Weight of *Eulipoa* chicks during their upward struggle (hatchlings) at an average depth of 50 cm and weight of chicks (fledglings) that reached the surface. All at Tanjung Maleo nesting grounds, Haruku Island, both in dry and rainy season.

depth (cm)		weight (g)		
average	range	average	range	n
50	10-80	69.1	59-92	15
0	surface	57.0	48-79	35

Emergence time

To monitor the time a hatchling needs to cover the distance to the surface (emergence time), 'premature' fledglings were reburied at the depth at which they were found and their activities were closely watched. It appeared, during the dry season, that it takes a hatchling an average of 24 hours to cover an upward distance of 20 cm (0.83 cm per hour, range 0.60 - 1.1 cm; n = 32). Twelve chicks had an exceptional average speed of 2 cm per hour (range: 1.7 - 2.4 cm). It should be noted that hatchlings did not dig continuously, but had moments of activity interspersed with periods of rest (see also: Jones et al. 1995), consequently the emergence speed per hour as given here are calculated averages. The experiments were not conducted during the rainy season, but we then expect the emergence time to be longer as the soil is damp, heavier and firm. As eggs are laid at an average depth of 48 cm during the dry season (see chapter 5, Table 11) it takes a chick 24-58 hours to reach the surface. In case of the average rainy season egg-depth of 79 cm (Table 11) a chick needs at least 39-95 hours to surface. For *Eulipoa* there are no data to compare. For mound-breeders, Jones et al. (1995) listed 2 - 15 hours for the malleefowl *Leipoa ocellata* and 1 - 2.5 days for the Australian brush-turkey *Alectura lathami*. For the burrow nesting maleo *Macrocephalon maleo*, they mentioned 'very slowly , often remaining within the material for several days'.

Fledging: emerging from the soil

Upon arrival at the surface, the soil surface breaks open and the chick pokes its head into the air and waits, breathing heavily (PLATE VI). We noted an average of 128 breathing movements per minute (n=17). While still with its body under the surface, the chick makes pumping movements with its wings, creating a cavity. In this 'exit-cavity' the chick is very vigilant. After a while the chick turns around and looks at its surroundings. Especially at daytime, it can wait for many hours, just sitting in the cavity, breathing heavily. Then, suddenly it jumps out and flutters into the direction of the forest that surrounds the nesting ground. In 95% of the cases, chicks emerged and fledged during hours of darkness.

It appeared that the upward journey and the time spent in the exit-cavity is of vital importance to loose the feather sheaths and develop the ability to fly. Premature fledglings were not able to fly. Chicks we bred in incubators could not fly till 2-3 days after hatching, having lost the feather sheaths. Siebers (1930) mentioned that an *Eulipoa* chick, unearthed too early and therefore not fully developed, was able to flutter after three days and fly off after a week. Clark (1960, 1964) noted that 'young megapodes can fly weakly on their hatching-day and are able to forage successfully within a day or so after hatching'.

After fledging, especially when the surface is wet (rainy season), a small round or oval pit is clearly visible in the soil (Fig. 30). When these 'exit-pits' are excavated, the internal cavity ('exit-cavity'), where the chick resided for some hours becomes visible (Fig. 31). Dimensions are given in Table 25.

Early morning counts of exit-pits proved to be a trustworthy method to establish the number of fledglings. During the rainy season and after

Table 25 Dimensions (in mm) of 181 exit-pits and exit-cavities of *Eulipoa* chicks, measured at the Tanjung Maleo nesting grounds, Haruku Island during the rainy season. (see Fig. 31)

	average	minimum	maximum	n
exit-pit (P)	55 x 56	40 x 40	80 x 93	181
exit-cavity (C)	81 x 81	65 x 65	100 x 115	181

Figure 30 Exit pits of *Eulipoa* fledglings seen from above (average dimensions are 55 x 56 mm, see Table 25). [photo C.J. Heij]

rainy nights in general, the pits were easy to locate. During the dry season the pits were less well marked due to inflowing sand, but could still be recognised by the trained eye. However, especially during the dry season, some exit-pits might be overlooked. We estimate that, on average per year, we missed about 10% of the fledglings. After the nesting grounds had been trodden on by the egg-collectors, no reliable counts of exit-pits could be made. Counts were therefore always executed before egg-collecting had started.

Behaviour after fledging

Once it has reached the forest, the fledgling presses itself flat against the forest floor and due to the cryptic plumage, can hardly be detected again (PLATE VII). Despite serious efforts during the entire study period, we only discovered about 10 fledglings in the forest. We noticed that they were passive at daytime, hiding between dry leaves on the forest floor. At night they became active and foraged. The same activity pattern was observed in captivity: chicks mainly passed the day asleep and at night they fed on the food we offered: locusts, millepedes, ants, termites, flies, beetles, worms, slugs, fruit (papaya, apple, melon) and seeds (maize, rice and poultry-food). In addition to foraging, captive chicks dug, jumped and fluttered continuously, often damaging themselves. In most cases captive chicks collapsed within a few days. Siebers (1930) also noticed the nightly activity of captive *Eulipoa* chicks and was not able to keep them alive for more than a few weeks.

The life and whereabouts of fledglings and juveniles of *Eulipoa wallacei* remains unknown. The fact that we hardly observed any fledglings in the forest of Tanjung Maleo indicates that they soon leave the area, otherwise the accumulation of chicks should have resulted in more sightings. When and how they leave is unknown. To answer questions such as ‘are they able to fly across the sea to Ambon and Seram while not fully grown?’, ‘do they remain on Haruku and move about on foot?’ and ‘when do they return to the nesting grounds to lay their first egg?’, further study is needed.

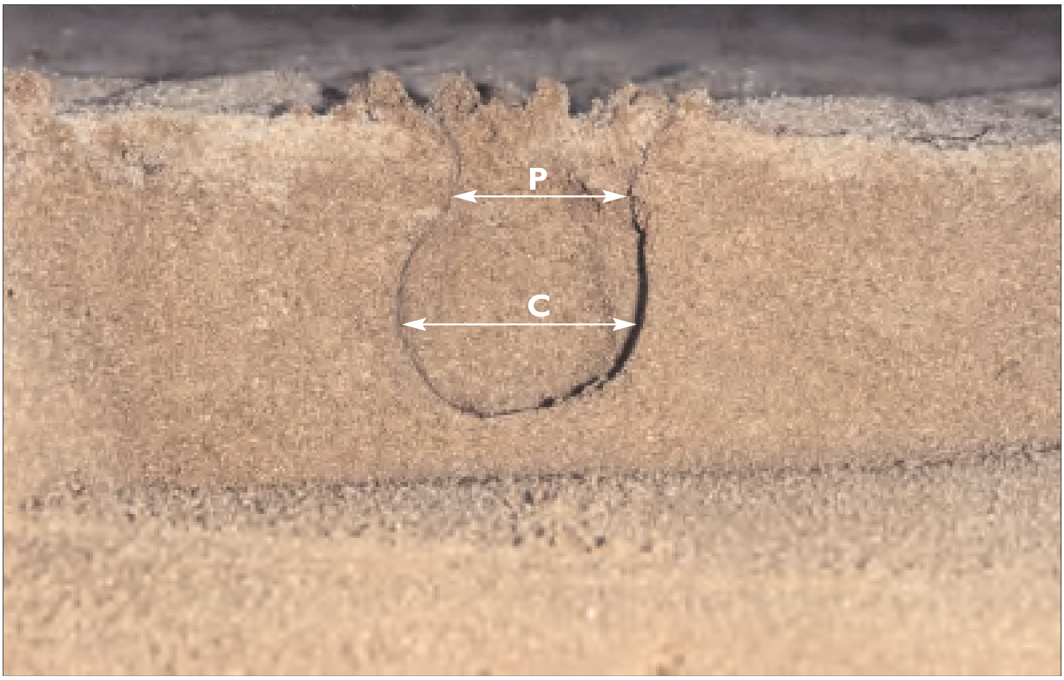

Figure 31 Lateral view of an excavated exit-pit (**P**) of an Eulipoa fledgling. The exit-cavity (**C**) is now visible (average dimensions of the cavity are 81 x 81 mm, see Table 25). [photo C.J. Heij]

8 HABITAT, HOME RANGE AND EGG-LAYING INTERVAL

Away from the sun-exposed beaches that are used as nesting grounds, the habitat of *Eulipoa wallacei* is generally described as 'mountain forest' (Ogilvie-Grant 1897; van Balen 1926; White & Bruce 1986; Sibley & Monroe 1990; Del Hoyo et al. 1994). Jones et al. (1995) added 'hill-forest' to this. Wallace (1869) called it 'forest of the interior' and Ripley (1960), for Bacan Island, described the habitat as 'evergreen rainforest' and 'subtropical wet moss forest' at a height of 750 - 1650 m. On the Western Papuan Island of Misool, though, two[6] male specimens were collected at altitudes of 100 and 300 m (Ripley 1960). Still, direct observations of the birds in their habitat are rare: Stresemann (1914a) encountered a small group in the forest of Hatu Sake (North Seram) at 1000 m and Heinrich (1956) collected the bird at 1500 m at Mount Sibela on Bacan Island. More recently the species was also observed on Seram both in coastal scrub (Bowler & Taylor (1989) and in disturbed primary forest close to cultivation at 230 m (Dekker et al. 1995).

We also observed several Moluccan megapodes away from their nesting grounds in coastal secondary forest and cultivated areas (gardens) in South Seram (Piru Bay, Amahai), North Seram (Wahai) and along the east and west coast of Haruku. Once even a bird was seen in the middle of a village. The question remains whether the birds use these lowland areas as their main habitat or as a transient between their nesting grounds and the mountain forests were they are supposed to occur.

The provenance of the birds that lay their eggs on Tanjung Maleo is not sufficiently known. Dekker (1991) and Dekker et al. (1995) argue that the total population that uses the area as a nesting ground is too large for Haruku, which has even no primary mountain forest. Therefore, the birds are expected to come from neighbouring Seram and Mount Salahutu on Northeast Ambon (Dekker et al. 1995; Jones et al. 1995). At Tanjung Maleo, the birds we saw flying in from the sea (see: chapter 4) do indeed indicate Seram and Ambon to be important source areas. There is, however, no proof.

Methods

In order to find out the origin and habitat of the Moluccan megapodes that use Tanjung Maleo as a nesting ground, a total of nine female birds were fitted with transmitters and immediately released on 11, 12 and 13 February 1996. Their whereabouts were monitored until 28 April 1996. The birds were caught in their burrow while, or just after, laying an egg and consequently were adult females. Bird and egg were weighed separately. Four birds got a transmitter fitted on the leg (tarsus) and five birds got the transmitter fitted on the back by means of a harness. The total weight of transmitter and attachment-kit was 15 g for the leg-type and 20 g for the harness-type (Table 26). Transmitter parts and battery were sealed in a waterproof PVC-tube. The nine transmitters and two universal transceivers (FT 290 R11, 150 MhZ) with two types of direction-sensitive antennas were obtained from IBN/DLO (Institute for Foresty and Nature Research), Wageningen, The Netherlands. To check the transceiver a test-transmitter was available. Each transmitter had its own programmed frequency and accompanying sound, hence the nine transmittered birds could be traced individually. Batteries were guaranteed to work for at least three months. The maximum distance between transmitter and transceiver should be 30 km, provided they were protected from extremely high temperatures and relative humidity. In the field however, at an average temperature of 30ºC and relative humidity of 85%, the maximum distance at which signals could be picked up by the transceiver, was 10 km in favourable circumstances (i.e. at night, clear weather, dry, plain terrain, open sea). Mountain forests appeared to be a

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[6] Although Ripley (1960, 1964) specifically mentioned two male specimens, our inventory of *Eulipoa* specimens in museum collections (see chapter 4, Table 8) revealed the presence of three male skins, all collected by Ripley on Misool in 1954: two in PMNH Newhaven (07341, 23-XI-1954; 073042, 19-XI-1954) and one in USNM Washington (518921, 19-XI-1954).

hindrance to receive signals. Even from an aircraft at an altitude of 700 m, the study area (Fig. 32A) could only be covered partly. The maximum period during which signals were received was 51 days for birds 1 and 9. Of the other transmittered birds, signals were received during a shorter period (Table 27). It is not known whether this is due to malfunctioning transmitters or the birds being out of reach.

To track the transmittered birds, one transceiver was permanently stationed at Tanjung Maleo and one was taken out to survey the entire study area which emcompassed Haruku, Pombo, Northeast Ambon, Saparua and the western, southwestern and southern part of Seram east to Amhahai (Fig. 32A). Tanjung Maleo was monitored every night to establish the period of time between visits of the individual females (the egg-laying interval).

The inland area of Haruku was monitored at least five times a week during daylight hours. This was done by motorbike and by foot (Mount Huruano was climbed on several occasions). On Northeast Ambon, Mount Salahutu was climbed twice, the rest of this area was covered by car and motorbike. A speedboat was used to monitor coastal South Seram and to track birds from the sea between Ambon, Seram and Haruku. Inland Seram was monitored by motorbike and car from the road that runs between Latu in the south and Kawa in the northwest. Entering this mountainous area was almost impossible. Therefore on 2 April a small aircraft was chartered to cover the traject Pattimura airport (Ambon) - Elpaputih Bay / Amahai (Seram). Figure 32A gives the total area covered by our surveys.

Tracking results

After being fitted with a transmitter and released, three birds left Tanjung Maleo within 30 minutes, two birds birds left after 1-2 hours and two birds stayed until dawn. Two birds kept within 1-2 km from Tanjung Maleo until the next

Table 26 Basic data on nine Moluccan megapodes *Eulipoa wallacei* (adult females) captured at the Tanjung Maleo nesting grounds and fitted with radio-transmitters (weights in g).

transmitter/ bird nr.	capture date & time	transmitter type	body weight	departure direction	notes
1	11 Febr 1996 (02.00 a.m.)	leg	477	SE	left Tanjung Maleo after 15 minutes
2	13 Febr 1996 (03.00 a.m.)	harness	526	SE	stayed at Tanjung Maleo till 16.00 p.m.
3	13 Febr 1996 (02.30 a.m.)	harness	527	ESE	left Tanjung Maleo after 30 minutes
4	11 Febr 1996 (02.20 a.m.)	leg	527	SE	stayed at Tanjung Maleo till 07.00 a.m.
5	12 Febr 1996 (01.30 a.m.)	leg	511	NE	stayed at Tanjung Maleo till 0.700 a.m.
6	12 Febr 1996 (02.00 a.m.)	leg	511	SE	stayed at Tanjung Maleo till 04.00 a.m.
7	13 Febr 1996 (03.30 a.m.)	harness	546	SSE	stayed 1-2 km SSE from Tanjung Maleo till 14 Febr, 02.00 a.m.
8	13 Febr 1996 (02.00 a.m.)	harness	500	NE	stayed at Tanjung Maleo till 03.15 a.m.
9	13 Febr 1996 (03.15 a.m.)	harness	536	SE	left Tanjung Maleo after 20 minutes

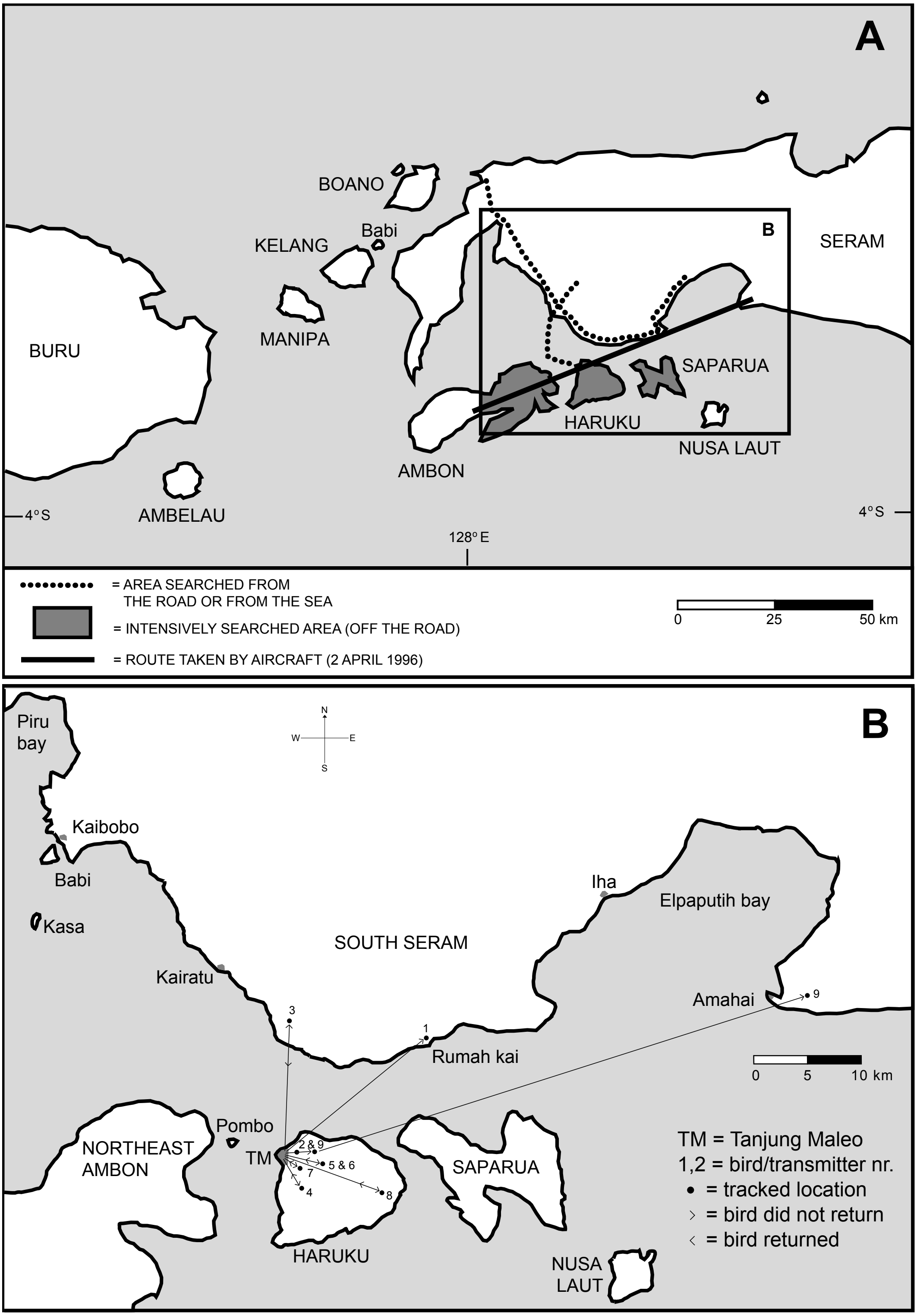


Figure 32 Buru and the Seram Island-group; **A** The area covered to trace nine radio-transmittered Moluccan megapodes; **B** tracking results (see also Table 27). [map graphics: Jaap van Leeuwen Design]

Table 27 Tracking results of nine adult female Moluccan megapodes *Eulipoa wallacei* fitted with radio-transmitters. (see Table 26)

bird number	transmitter-fitting date	returning date(s) at nesting ground	time-interval	tracked locations other than Tanjung Maleo	date(s)	distance from Tanjung Maleo
1	11 Febr	--	--	South Seram (Rumah Kai[1])	2 Apr	20 km
2	13 Febr	--	--	Central Haruku	13 Febr[2]	3-5 km
3	13 Febr	23 Febr 10 March	10 days 16 days	South Seram (12 km E of Kairatu[3])	4-23 March	15-20 km
4	11 Febr	26 Febr	15 days	Central Haruku	11-13 Febr, 23 Febr	4-6 km
5	12 Febr	--	--	Central Haruku	13 Febr	2-4 km
6	12 Febr	26 Febr	14 days	Central Haruku	13-14 Febr	3-5 km
7	13 Febr	25 Febr	12 days	Central Haruku	14 Febr[5]	1-2 km
8	13 Febr	24 Febr 7 March 19 March	11 days 12 days 12 days	Central Haruku	13 Feb - 25 Mar[4]	4-10 km
9	13 Febr	--	--	Central Haruku South Seram (Amahai[1])	13 Febr[2] 2 Apr	3-5 km 50 km

[1] tracked from an aircraft at 2000 ft.
[2] till 16.00 p.m.
[3] tracked from the beach north of Tanjung Maleo and from Pombo Island
[4] almost daily during that period
[5] till 02.00 a.m.

evening/night (Table 26). The next two days, four birds were tracked down on the high plateau of Haruku between altitudes of 100 and 300 m. Of these four birds one was never found again, two returned to Tanjung Maleo on 25 and 26 February and one bird (number 9) was tracked down on 2 April near Amahai on South Seram at a distance of 50 km from Tanjung Maleo (Table 27, Fig. 32B). The signals of bird 4 and 8 were heard for a longer period. Number 4 was present on the Haruku plateau from 11 till 13 February and on the 23rd of that month; on the 26th she laid an egg on Tanjung Maleo. Number 8 was constantly present on the Haruku plateau between 13 February and 25 March, and returned three times in that period to Tanjung Maleo for egg-laying purposes. Bird number 3 appeared to have left for Seram. She was tracked down in the hills east of Kairatu and her signal could even be heard almost contantly between 4 and 23 March from the beach north of Kailolo and from Pombo island. She returned twice (23 February and 10 March) to Tanjung Maleo. The distance covered was 15-20 km. One bird (number 1) of which the signal was only heard for 15 minutes after she was released, was found in the hills near Rumah Kai on South Seram on 2 April. She never returned to Tanjung Maleo during the period she was monitored (Table 27, Fig. 32B).

Inland habitat

Of the nine birds fitted with a transmitter, six lingered for a shorter or longer period on the high plateau of Haruku. Bird 9 used it as a transient area on her way to Seram. Probably for birds 4 and 6, and certainly for bird 8, this area forms a permanent inland habitat. The plateau rises straight up from the sea to a height of 100 m. It features hills of mostly 200 - 500 m altitude. The highest point is Mount Huruanu, which reaches 500 m. A number of rivers runs from southern, western and northern directions into the sea. The area consists of tertiary (Miocene) formations with mountain ridges of limestone and coral (Riedel 1886). The plateau is mainly overgrown with neglected plantations. It is wild parkland with age-old trees like the 'kenari' *Canarium commune* and 'durian' *Durio zibethinus* which serve as shadow trees for coconut-palm *Cocos nucifera*, nutmeg *Myristica fragrans*, cloves *Eugenia aromatica* and in the lower areas and along the rivers banana *Musa* sp. and sago palm *Metroxylon* sp. These plantations have been very badly maintained during the past few years, which has created a thick shrub layer consisting of grasses, ferns and seedlings of plantation trees. The vegetation is lush and the soil very humid: it houses a rich fauna both on the forest floor and in the soil. This apparently plentiful food supply in the hills of Central Haruku could be the incentive for the birds, after having laid their eggs and having an empty stomach (Toxopeus 1922; Siebers 1930), to forage there for a while before they cross to Seram. Still, the area must be the inland habitat for a good part of the Tanjung Maleo breeding-population.

The secondary forest with limestone formations of Central Haruku as described above, is similar to the coastal hill-vegetation of South Seram where we found three transmittered birds. Near the village of Latu, South Seram, which we visited on 24-26 February 1996, a local professional birdcatcher knew *Eulipoa* well from the inland habitat (PLATE VIII) and described how small groups run through the dense vegetation and even claimed to have observed courtship behaviour. His description is similar to that of the local egg collectors of Tanjung Maleo, regarding their observations of small *Eulipoa* groups on the Haruku plateau and also resembles the behaviour of the groups we observed after darks nights in the forest that surround the Tanjung Maleo nesting grounds (see: chapter 4). Stresemann (1914a) encountered similar behaviour in the forest of Hatu Saku, a mountain pass at 1000 m in North Seram.

In conclusion, the fact that *Eulipoa wallacei* regulary occurs in degraded secondary forest at rather low altitudes and even in neglected cultivated areas, may indicate that the species has adapted to the loss of primary mountain-forest habitats where they were encountered by the early explorers. If this is the case throughout its range, the chances of survival of the species might increase considerably.

Egg-laying interval

Of the nine transmittered birds, five (55%) returned to the nesting grounds, supposedly for the purpose of egg laying. Of these five birds, three returned once, one returned twice, and one returned three times, so the total number of return-cases was eight. From these data (Table 27) the average egg-laying interval (i.e. the period of time between two consecutive visits to the nesting ground) was established at 13 days (range 10-16 days, calculated average is 12.75, for convenience put at 13). It should be noted though that the birds were transmittered in February, about two months before the end of the dry season. As the number of eggs collected on Tanjung Maleo cleary increases from the end of the rainy season (in August/September) onwards and reaches a maximum in the dry season, after which the numbers decrease to a minumum in July (Heij 1995a, see also: chapter 9, Fig. 34), some of the birds probably had laid their last egg of the season on the night they were fitted with a transmitter and could be expectednot to return before August/September. This explains the absence on the nesting grounds of birds 1 and 9 that were eventually tracked down in Seram. The lack of observations of birds 2 and 5 (which disappeared after 1-2 days) might be due to a malfunctioning transmitter.

The average egg-laying interval of 13 days established by radio-telemetry applies to birds visiting the nesting grounds at the end of the dry season (February-March). The question remains whether individual birds lay at constant intervals throughout the year, or concentrate their egg-laying activities in the dry season. The latter seems to be the case as peak numbers of eggs are found in the dry season (Heij 1995a): the number of eggs laid during the rainy season is only about one third (31.6%) of the total egg production (see: chapter 9, Table 28). The fact that still quite a number of eggs are laid during the rainy season is probably caused by individual birds starting their laying-period already in the rainy season and birds that start in the course of the dry season and continue into the rainy season. In case birds do spread their laying activities over the year (both seasons), the calculated interval during the rainy season (based on the egg-production ratio of 1/3 rainy season, 2/3 dry season: 100/68.4 x 12.75) is expected to be about 19 days. We do not regard this possibility as likely.

Data on the egg-laying interval of other megapode species are rare. Jones et al. (1995) give 2-9 days for the Australian brush-turkey *Alectura lathami* and 13 for the orange-footed megapode *Megapodius reinwardt*, both mound-breeding species. For burrow-nesters there is no information on the interval, but their egg-laying season is said to start after the end of the rainy season when the substrates have warmed.

9 NUMBERS: EGGS, FLEDGLINGS AND ADULTS

During the periods 1 June 1994 - 30 June 1995 and 1 February - 30 April 1996 the numbers of harvested eggs and fledged chicks were established by the author(s) through direct counts carried out in the field. For the preceding period (dating back to the 1987/1988 harvest year) the egg numbers were kindly supplied by the former lease holders who each had kept an accurate administration (Fig. 3). As the lease holders only had registered the numbers of eggs available for sale, we had to add approximately five eggs to the daily numbers exceeding 30 and approximately ten eggs to the daily numbers exceeding 100. This addition relates to the remuneration (in eggs) received by the collectors. Each lease holder, however, had his own key to calculate the actual number of collected eggs. These corrected egg numbers apply to the harvest years 1987/1988, 1988/1989, 1989/1990, 1991/1992, 1992/1993, 1993/1994 and the first two months of the 1994/1995 harvest year. With the exception of the period 1 February - 30April 1996, the data of the harvest years 1995/1996 (after 30 June 1995) and 1996/1997 were obtained through monthly correspondence with the lease holder(s) and needed no corrections.

Appendices 1 and 2 list the basic data on egg and fledgling numbers.

Numbers of harvested eggs
Figure 33 shows the numbers of eggs harvested at Tanjung Maleo from 1987/1988 till 1996/1997. In the course of the years, an increase is clearly visible: from 1987/1988 till 1994/1995 the harvest almost doubled, whereas afterwards the numbers stabilized close to 37000 - 38000 eggs. We expect that now (1996/1997) the maximum harvest is reached: the capacity of the birds, the area and the collectors has come to an end. The increasing numbers of harvested eggs are, however, not the result of more birds visiting Tanjung Maleo for egg-laying, but are caused by increasing and more intensive egg-collecting activities. The higher lease price (see: chapter 3, Table 4) and the increasing demand for eggs, forced the lease holder to act like any other entrepreneur would do: hire more personnel and intensify the activities. As many eggs as possible are collected. Local egg-collectors and elderly villagers reported that 'in the past' (probably a few decades ago), many more egg-laying birds visited the Tanjung Maleo nesting grounds.

Table 28 Numbers of harvested *Eulipoa* eggs at the Tanjung Maleo nesting grounds in the harvest years 1987/1988 - 1996/1997, divided in rainy season (April - September) and dry season (October - March). A harvest year runs from 1 April till 31 March. Based on data listed in Appendix 1.

	number of harvested eggs			
harvest year	total	rainy season	dry season	% dry season
1987/1988	18260	6085	12175	66.7
1988/1989	27978	9655	18323	65.5
1989/1990	22934	7898	15036	65.6
1990/1991	no data			
1991/1992	27648	8796	18852	68.2
1992/1993	26886	9981	16905	62.9
1993/1994	32722	11185	21537	65.8
1994/1995	36263	11253	25010	69.0
1995/1996	36618	10095	26523	72.4
1996/1997	37712	9425	28287	75.0
total/average	267021	84373	182648	68.4

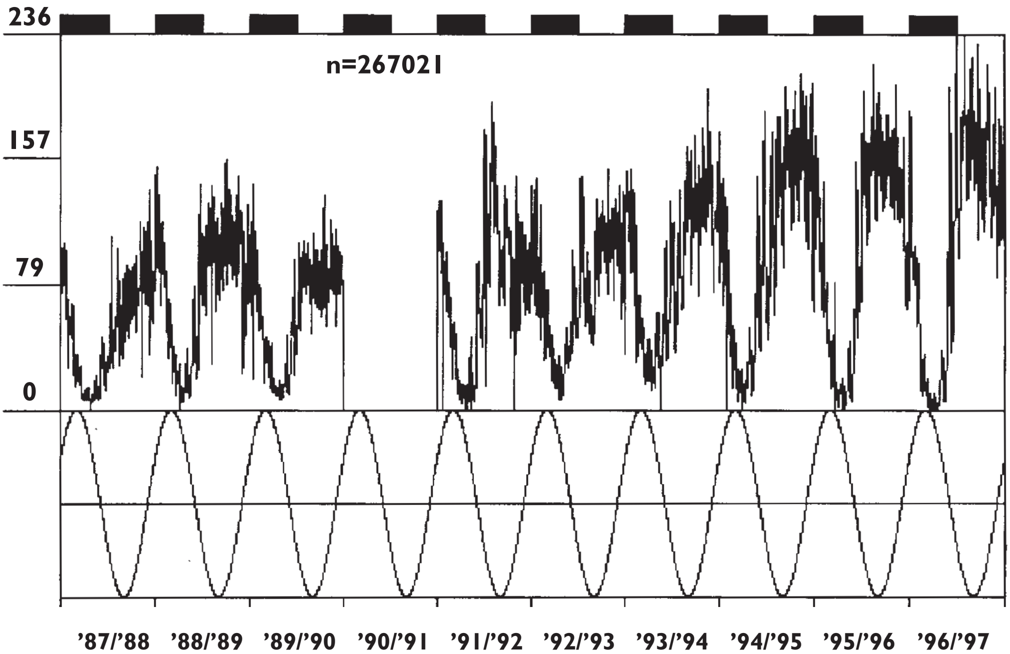


Figure 33 Numbers of collected eggs of *Eulipoa wallacei* at Tanjung Maleo in the course of the period 1 April 1987 - 31 March 1997 (see Table 28 and Appendix 1) together with course of the solar cycle (sinusoid line) and indications of the rainy season (black bars). Data from the 1990/1991 harvest year are lacking.

Then, apparently with little effort, daily numbers of harvested eggs regulary reached 300 or more, while nowadays numbers exceeding 200 per day are seldomly collected (see: Table 30). The effort is, however, much greater.

Table 28 lists the total numbers of collected eggs per harvest year and separates the numbers found in the rainy season and the dry season. On average 68,4% (range 62.9-75.0%) of the eggs are found during the dry season (October - March), meaning a dry : rainy ratio of about 2:1. This seasonal pattern is not biased by more or less collecting activities (pers. observations), but clearly caused by low numbers of birds visiting the area during the rainy season. To some extent, this pattern is known for other burrow-nesting megapodes such as *Megapodius eremita* and *Macrocephalon maleo*, and is generally believed to be an adaptation to the temperature of the substrate (Jones et al. 1995). For *Macrocephalon maleo*, Dekker (1988) found that coastal (sandy) nesting sites were mainly used during the dry season, whereas inland geothermal incubation sites were used all year round. The sun, regulary absent during the rainy season, apparently could not heat up the wet soil of the coastal nesting grounds. Temperature readings in nesting burrows at Tanjung Maleo (see: chapter 5, Table 11) did indeed reveal lower temperatures during the rainy season. At greater depths (where eggs are laid), differences between both seasons were, however, slight and temperatures remained at values suitable for year-round incubation.

Despite the clear seasonal pattern, eggs are laid all the year round. In nine years (3285 days) only 14 days did not yield a single egg (Table 29). From the basic data on the egg-harvest listed per day and month in Appendix 1 and the graphs computed from that data-base (Fig. 34), it appears that the lowest numbers of eggs are found in the midst of the rainy season, in the months of June, July and August. The month of July features, without exception, the mininum egg-numbers: on average 1.7% (range 0.4-2.5%) of the total harvest (Table 29). As Jones et al. (1995) already

Table 29 Monthly distribution of the lowest numbers of harvested *Eulipoa* eggs at Tanjung Maleo per harvest year. Data from Appendix 1. See also Figure 34.

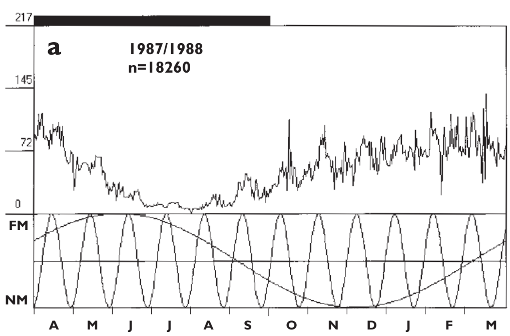
harvest year	lowest numbers in (minimum underlined)	% in July	no eggs on
1987/1988	June, <u>July</u>, August	1.5	July 31
1988/1989	June, <u>July</u>, August	1.5	July 8
1989/1990	June, <u>July</u>, August	1.9	--
1990/1991	no data		
1991/1992	June, <u>July</u>, August	1.1	August 1 & 15; January 31*
1992/1993	<u>July</u>, August	2.5	--
1993/1994	June,<u>July</u>, August	2.4	August 20
1994/1995	June, <u>July</u>	1.7	May 5*, June 28
1995/1996	June, <u>July</u>, August	0.7	June 22; July 23 & 28
1996/1997	June, <u>July</u>	0.4	June 30, July 8 & 18
	average percentage of eggs in July:	1.7	days without eggs 14 (0.4%)

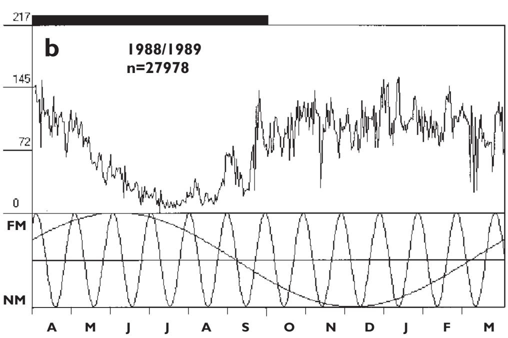
* neighbouring days yielded large numbers, there were probably no collecting activities due to social events.

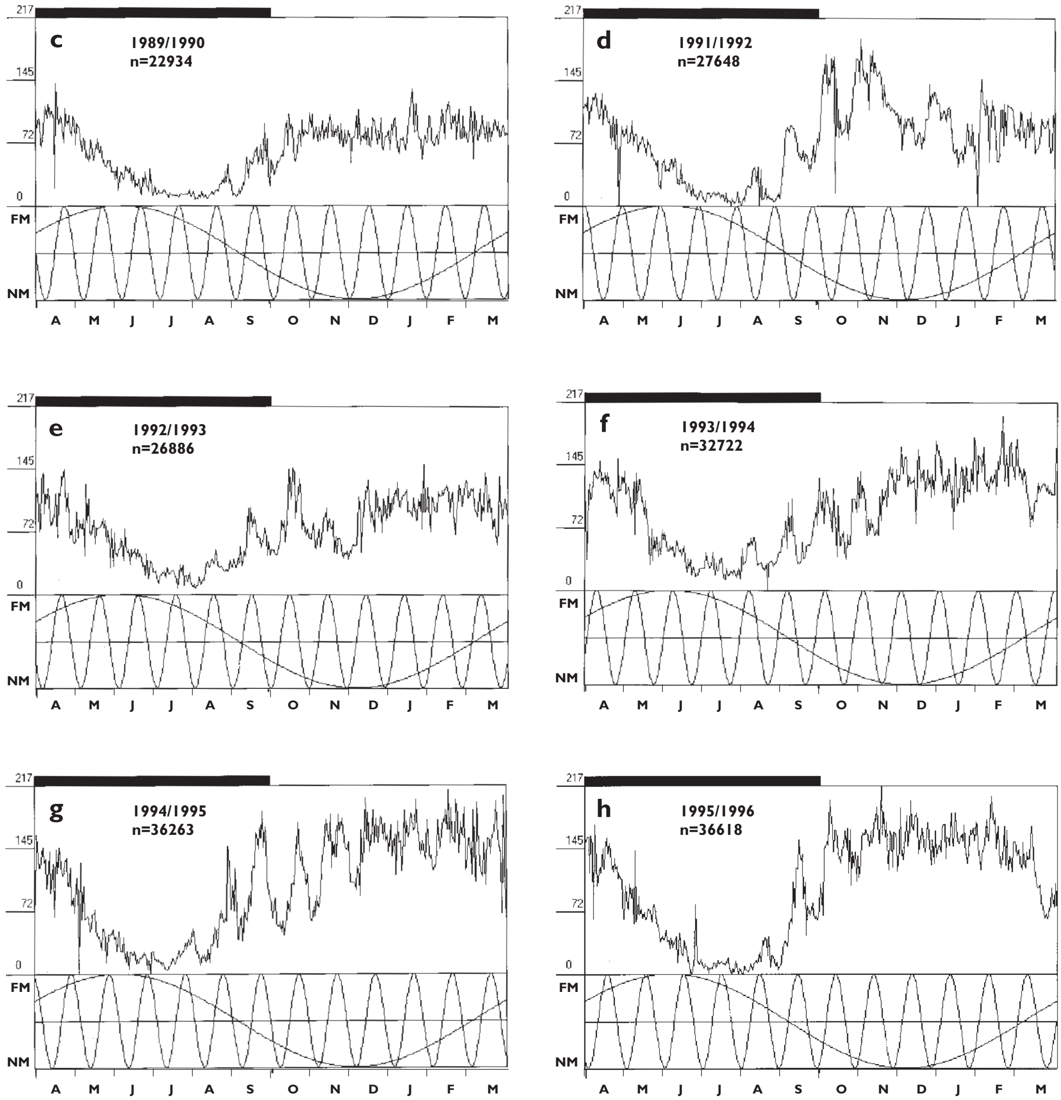
emphasized for megapodes in general, it should be noted that prolonged patterns of egg laying do not mean that particular individuals produce eggs all the year round. Rather, these patterns result from the overlap of many birds using the nesting ground for short, irregular periods.

Still, most egg production at Tanjung Maleo (68.4%) is concentrated in the dry season. Fluctuations in the numbers of harvested egg are visible in Figure 34 and the occurrence of peak numbers is summarized in Table 30. Contrary to the lowest numbers (each year in July), the highest monthly totals of eggs are found in different months each year, but were mostly recorded in November (twice), December (twice) and January (three times), all in the midst of the dry season. March and April, bordering the change of seasons, each featured the highest monthly totals once. The average percentage of the total harvest found in the peak month is 13.2 and is, with a range of 12.2-15.1, remarkably constant in each year (Table 30). The maximum number of eggs collected during one day is also given in Table 30. Those numbers range from 113 in 1989/1990 to 236 in 1996/1997 and were recorded in four different dry season months (November, January, February, March).

The inclusion of the lunar cycle (29.53 days according to the synodic method [Bodifée 1983]) in Figure 34 clearly shows that throughout the







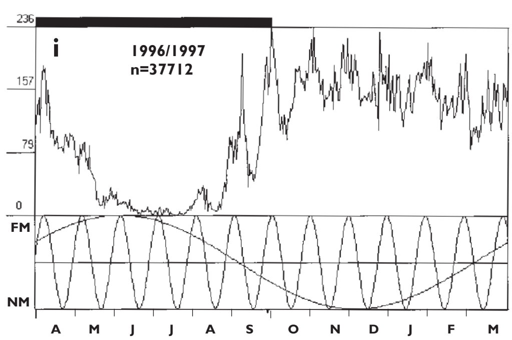


Figure 34 Numbers of collected eggs of *Eulipoa wallacei* in the course of nine separate harvest years (1 April - 31 March), together with the solar cycle (long sinusoid line), the lunar cycle (short sinusoid line; FM = full moon, NM = new moon) and an indication of the rainy season (black bar).

Table 30 Monthly distribution of the highest numbers of harvested *Eulipoa* eggs at Tanjung Maleo per harvest year. Data from Appendix 1. See also Figure 34.

harvest year	highest numbers in (peak-month underlined)	% in peak-month	maximum number of eggs (date)
1987/1988	Apr, Jan, Feb, <u>Mar</u>	14.2	138 (16 March)
1988/1989	Apr, Dec, <u>Jan</u>	12.2	156 (9 January)
1989/1990	<u>Apr</u>, Nov, Jan, Mar	12.5	113 (3 March)
1990/1991	no data		
1991/1992	Apr, Oct, <u>Nov</u>	15.1	193 (2 November)
1992/1993	Apr, <u>Jan</u>, Mar	12.1	150 (26 January)
1993/1994	<u>Dec</u>, Jan, Feb	12.8	201 (18 February)
1994/1995	Dec, <u>Jan</u>, Feb, Mar	13.4	211 (15 February)
1995/1996	Nov, <u>Dec</u>, Jan	13.4	217 (16 November)
1996/1997	Oct, <u>Nov</u>, Dec, Mar	13.6	236 (2 November)
average percentage of eggs in peak-month:		13.2	

year, peak numbers are found during full-moon periods (see also: Heij 1995a). To explain this phenomenon we can only speculate. Egg maturation might coincide with the lunar cycle, causing most birds to have an egg ready to be laid at full moon. The egg-laying interval (13 days) is, however, much shorter than the lunar cycle (see: chapter 8). A full moon in combination with a cloudless sky causes the nesting grounds to be well lit and might trigger birds to leave their inland habitat for egg-laying. Observations in the field (see: chapter 4) indeed revealed that during dark nights, birds were very reluctant to enter the nesting ground and hesitated to start digging burrows. Under such circumstances most digging and laying was done at daybreak. It should be noted that a full moon does not guarantee the nesting grounds to be well lit: a clouded sky still causes a pitch-dark night. This matter, therefore, needs to be studied more into detail.

Small-scale fluctuations in the number of harvested eggs are hard to explain. Direct observations in the field during 1994/1995, however, revealed that social events such as the nightly tv-broadcasting of the 1994 soccer worldchampionship, the annual muslim fasting (ramadan) and the absence for longer periods of the lease holder, causes less intensive ('lazy') or no egg-collecting activities and, as a consequence, a lower or no harvest, although the birds did lay eggs. We strongly believe that these circumstances are of great importance to the survival of the *Eulipoa* population: they account for the rather sudden peaks in the number of recorded fledglings (see below). Besides, the regular occurrence of fledglings and the finds of hard-set eggs proves that – despite their serious efforts – the collectors are not able to collect all eggs. A certain percentage (13.7 in 1994/1995, see below) is simply not found and has a chance to hatch.

Numbers of fledglings

The numbers of fledglings were established by counting the little round craters in the soil (exit-pits) from where they have emerged (see: chapter 7, Fig. 30). Figures 35, 36 and 37 show the fluctuations in the numbers in the course of three 'fledgling years' in the period 1 July 1994-31 March 1997. To ease comparison with data on the egg-numbers (Fig. 34), the 'fledgling year' runs from 1 July till 30 June. This three month shift in comparison with the 'harvest year' is necessary as the duration of the incubation period is about 2-3 months (see: chapter 6, Table 21). The total number of hatchlings that results from the eggs that have been laid in the harvest year (1 April - 31 March) is therefore expected to emerge from the soil in the period

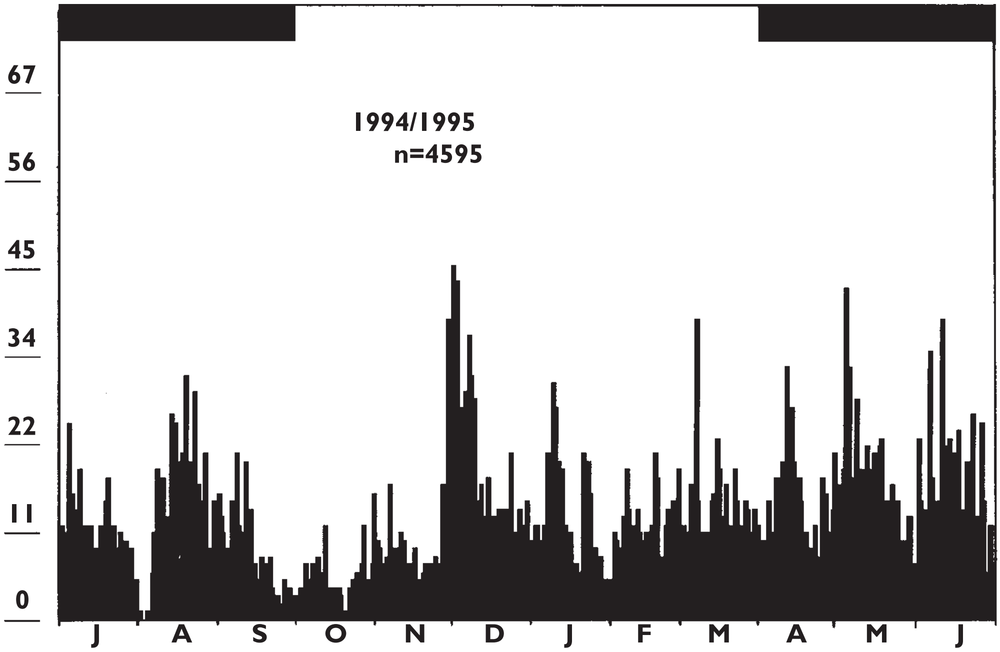


Figure 35 Numbers of fledged chicks of *Eulipoa wallacei* established by the presence of 'exit-pits' (see Fig. 30) at the Tanjung Maleo nesting grounds in the course of the period 1 July 1994 - 30 June 1995 (horizontal black bars indicate the rainy season).

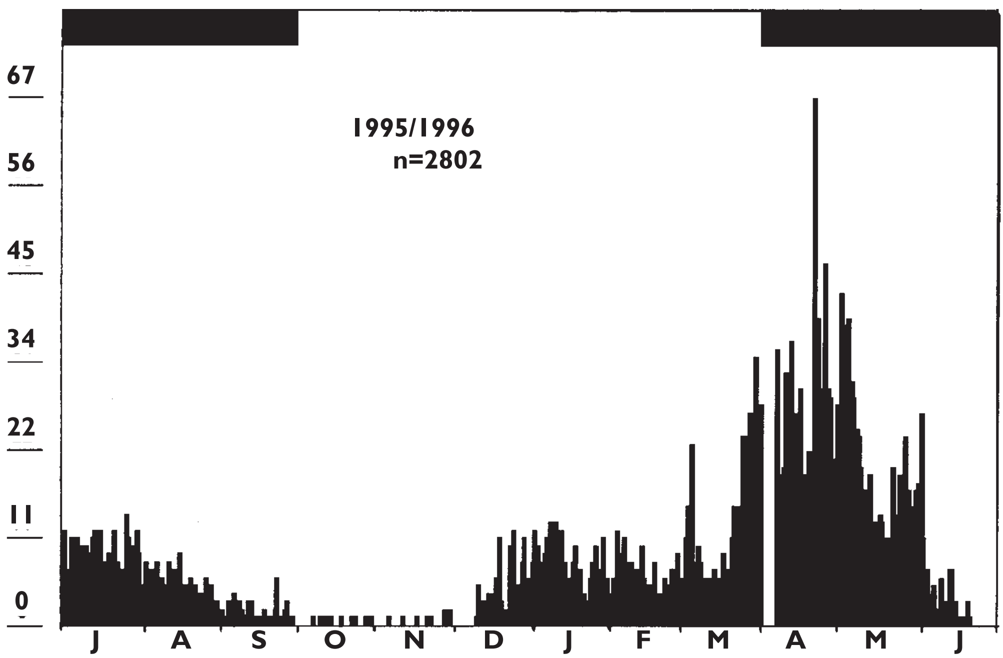


Figure 36 Numbers of fledged chicks of *Eulipoa wallacei* established by the presence of 'exit-pits' (see Fig. 30) at the Tanjung Maleo nesting grounds in the course of the period 1 July 1995 - 30 June 1996 (horizontal black bars indicate the rainy season).

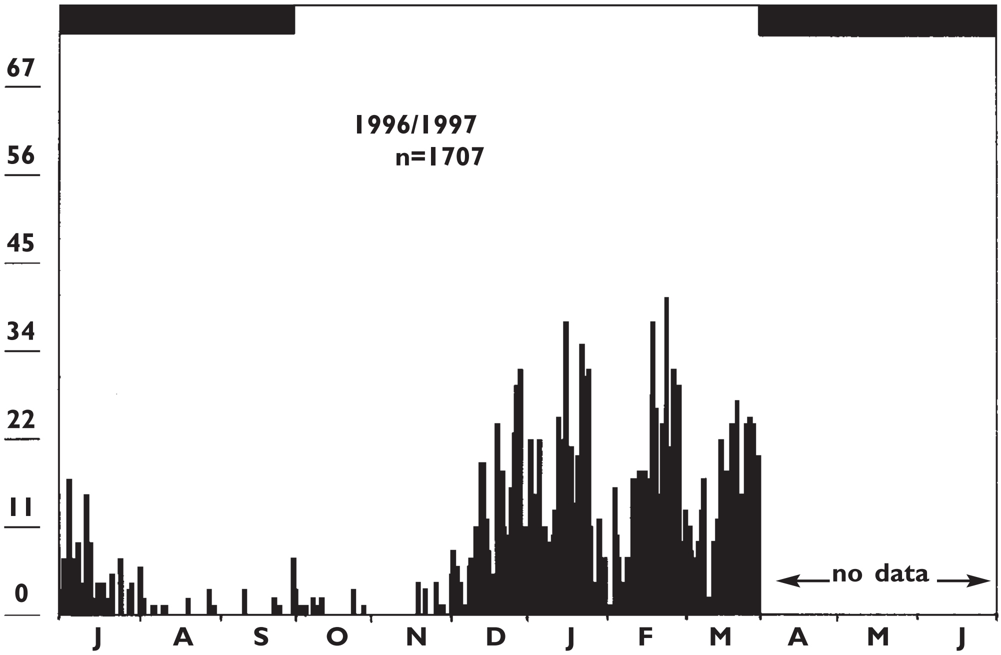


Figure 37 Numbers of fledged chicks of *Eulipoa wallacei* established by the presence of 'exit-pits' (see Fig. 30) at the Tanjung Maleo nesting grounds in the course of the period 1 July 1996 - 31 March 1997; data from April-June were not yet available (horizontal black bars indicate the rainy season).

1 July - 30 June (the fledgling year). When analysed on a monthly basis, we see the lowest numbers of fledglings (0.4-3.1 % of the yearly total) in the period September -November (Table 31). This pattern clearly reflects the lowest egg-production in the period June-August (*cf.* Table 29), being about 2-3 months earlier.

As with the peaks in egg production, the occurrence of peak numbers of fledglings does not show a well-marked pattern. Although, in 1994/1995, the maximum fledgling numbers in December 1994 (Table 32, Fig. 35) do mark the rather sudden dip in the egg-harvest during the first half of October 1994 (Fig. 34g). Here, we probably see the influcence of low egg-collecting activities. The high fledgling numbers in May-June 1995 (Fig. 35, Table 32) reflect the high egg-production during January-March (Table 30, Fig. 34g), when the chance of eggs being overlooked by the collectors is greater than in periods when egg numbers are low . In 1995/1996 the highest egg-production was recorded in November-January (Table 30, Fig. 34h) and, likewise, the numbers of fledglings

Table 31 Monthly distribution of the lowest numbers of *Eulipoa* fledglings at Tanjung Maleo per fledgling year. Data from Appendix 2. See also Figs. 35, 36 and 37.

fledgling year	lowest numbers in (minimum underlined)	% in minimum month(s)
1994/1995	September, <u>October</u>, November	3.1
1995/1996	September, <u>October</u>, <u>November</u>[1]	0.4
1996/1997	<u>September</u>, <u>October</u>, <u>November</u>[2]	0.4

[1] both underlined months yielded 10 fledlings each.

[2] underlined months yielded 13,14 and 13 fledglings respectively.

Table 32 Monthly distribution of the highest numbers of *Eulipoa* fledglings at Tanjung Maleo per fledgling year. Data from Appendix 2. See also Figs. 35, 36 and 37.

fledgling year	highest numbers in (peak month underlined)	% in peak month	maximum number of fledglings (date)
1994/1995	<u>December</u>, May, June	12.8	45 (2 December)
1995/1996	March, <u>April</u>, May	24.9	67 (21 April)
1996/1997	no complete data		

peaked in March-May (Fig. 36). The 67 hatchlings that emerged from the soil on 21 April 1996 form a distinct peak (Fig. 36), which should indicate low egg-collecting activities in early February. Figure 34h, indeed, shows relatively low harvest results during that period (see also Appendix 2). The fledgling numbers in 1996/1997 (Fig. 37) are not analysed as the data of the period April-June 1997 were not available at the moment of update and final editing of this paper.

Total egg production

The availability of both the numbers of collected eggs and the numbers of fledged chicks, enabled us to calculate the total egg production for the Tanjung Maleo nesting grounds. To these two parameters we add some corrections. (1) We estimate to have missed 10% of the fledglings (see: chapter 7) and add this percentage to the fledgling numbers. (2) We estimate the natural losses of eggs due to infertility and predators other than humans to be about 5 per week. (3) Additional losses of eggs and/or hatchlings due to collecting-activities are about 9 per week. The 1994/1995 harvest year is used for this calculation as the data were obtained by direct observations in the field. Table 33 lists the results. A total of 42039 eggs was produced. Of this total, 86.3% was collected, 1.7% was lost due to predation or damaged otherwise, and 12% resulted in fledged chicks.

Total egg-laying population

Knowing the total egg production of the Tanjung Maleo nesting grounds, the next step is to establish the number of egg-laying females involved. Basic to this are (1) the number of eggs produced per female (the 'clutch size') in a certain period, generally called the 'breeding season' (but in case of megapodes better called 'laying season'), and (2) the egg-laying interval.

As noted earlier, we have established that most eggs (68.4%) are laid in the dry season, which, for that reason, we may call the laying season. Nevertheless, a considerable percentage of the eggs (31.6) is laid during the rainy season which is of about the same length as the dry season. We can therefore state that at Tanjung Maleo, the moment a bird starts her laying season differs individually and does not necessarily coincide with the end of the rainy season (see: chapter 8). With a range of 10 to 16 days (average 13 days) the egg-laying interval appeared to be rather constant (Table 27).

For *Eulipoa wallacei* and most other (burrow-nesting) megapodes, the clutch size is not known or poorly understood (Jones et al. 1995). Dekker (1990) estimated the egg production of the burrow-nesting *Macrocephalon maleo* at 8-12 per season, and Jones et al. (1995) listed 15-24 eggs per year for the mound-breeding *Leipoa ocellata*. For *Megapodius reinwardt*, also a mound-breeder, Del Hoyo et al. (1994) mentioned a clutch size of 12-13 eggs.

We were not able to establish the average egg production of an individual *Eulipoa* through direct field observations. However, the study of the ovaries of four *Eulipoa* specimens that collided with electricity wires at Tanjung Maleo in April/May 1995, revealed the following information: in addition to a fully matured egg (ready to be laid), the ovaries each contained an average of 23 oocytes smaller than 1 mm in dia-

Table 33 A calculation of the total egg-production of *Eulipoa wallacei* at the Tanjung Maleo nesting grounds in the 1994/1995 harvest year (1 April 1994 - 31 March 1995).

collected eggs in 1994/1995 harvest year		36263	(86.3%)
fledged chicks recorded during 1 July 1994 - 30 June 1995	4595		
fledged chicks not noticed (10%)	459		
total offspring	5054	5054	(12.0%)
natural losses (estimated average 5 per week)*		260	(0.6%)
reburied hard-set eggs** (1 July 1994 - 30 June 1995)	202		
losses of hard-set eggs/hatchlings (average 5 per week)	260		
extra losses through collecting activities	462	462	(1.1%)
total egg production in 1994/1995 harvest year		42039	(100%)

* through infertility, predators other than humans etc; these eggs do not hatch and are not found either.

** we reburied undamaged hard-set eggs (75.6% hatched); normally they are destroyed by the collectors; therefore they are listed here as losses.

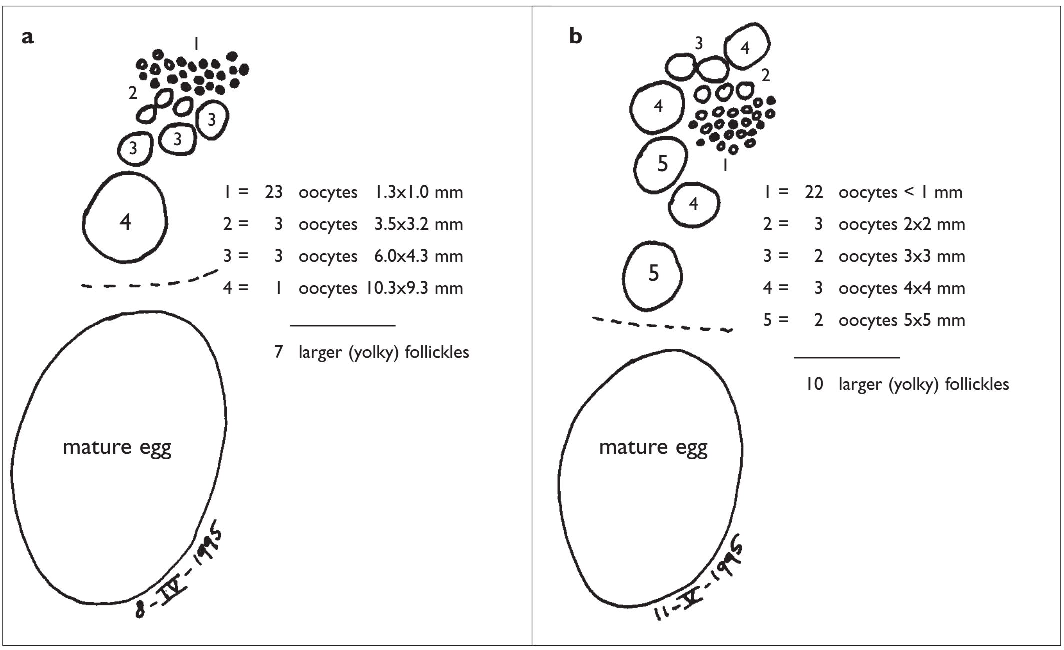


Figure 38 The contents of two ovaries of *Eulipoa wallacei* found dead at Tanjung Maleo: **a** from specimen NMR 999700283 (finding date 8 April 1995); **b** from specimen NMR 999700265 (finding date 11 May 1995). [illustration: C.J. Heij; not to scale]

meter and an average of 9 larger oocytes (yolky follicles) having diameters ranging between 2 and 10 mm (Fig. 38). Assuming that the mature egg was the last of a 'clutch' laid in the course of the preceding months (the rainy season starts in April/May), we expect the larger oocytes to develop further during the next dry season.

Based on these observations and the data on clutch sizes of other megapodes as listed above, we expect the clutch size of *Eulipoa wallacei* to be at least 10 eggs per laying season. The maximum probably does not exceed 12 eggs. With a total production of 42039 eggs (Table 33) the total number of egg-laying females at Tanjung Maleo is about 4200. With the average egg-laying interval of 12.75 days and assuming that eggs are laid at more or less constant intervals during a certain period (mostly coinciding with the dry season), we expect a complete 'clutch' to be laid during an average period of 127.5 days or about four months and one week (range 100-160 days). This assumption is, however, rather speculative as the individual egg-production ('clutch size') of *Eulipoa* is not exactly known.

Recruitment and survival

Based on the data of the 1994/1995 harvest year (Table 33), each egg-laying bird, on average, produces only about one fledgling per year. As we expect the percentage of fledglings reaching sexual maturity to be very low, recruitment, in the end, will be minimal. The fact that, despite the continuous high human pressure on hatching-success, still large numbers of *Eulipoa* visit Tanjung Maleo, is miraculous. We believe that the few individuals that manage to become adult, must have a high life expectancy. Otherwise the breeding population of the Tanjung Maleo nesting grounds should have become extinct long time ago. The question is now, how long the species can sustain the ongoing and intensified exploitation of its eggs.

10 PREDATORS AT TANJUNG MALEO

We expected the Tanjung Maleo nesting grounds to attract a wide range of predators as the main potential prey - *Eulipoa wallacei* - occurs in three types (eggs, chicks and adults) and in high densities. Adults are mostly present on the nesting grounds during the hours of darkness, and sometimes also in the surrounding forest during the day (see: chapter 4). Chicks can be encountered any time, but mostly emerge from the soil during the night. Egg are most vulnerable to predation during the nightly laying activities, but can theoretically be preyed upon during daytime as well. However, the main predator of eggs, *Homo sapiens*, makes sure that after the early morning hours almost nothing is left for other predators: on average 86.3% of the total egg production has been collected. We expect egg predation by predators other than man to be low and calculated it at about 0.6% of the total egg production (see: chapter 9, Table 33). This low rate is also influenced by humans: killing other predators is part of the maintenace of the nesting grounds (see: chapter 3).

The predators of *Eulipoa wallacei* that we encountered during observations, both at night and day, and those that are said to occur at the nesting grounds according to local information, are listed in Table 34.

Man

Homo sapiens is beyond doubt the main predator of *Eulipoa wallacei*. During the last decade, he is responsible for the collecting and consumption of 80-90% of the total egg production at Tanjung Maleo (see: chapter 9). This rate is not known for the preceding period, but the collecting of eggs at the site and on the islands of Pombo and Kasa has been known since about 1870/1890 (Van Hoëvell 1875; Martin 1894) and probably dates back much earlier. As eggs are actually consumed, the term 'predation' is justified. In this way man is and has been the main factor in influencing the size and stability of the *Eulipoa* population. Apart from the direct predation on eggs, an estimated weekly average of nine newly hatched chicks and/or hard-set eggs destroyed during the collecting activities by the spade of the diggers. Chicks occasionally die when the ground is heavily tamped down after the collecting activities. Especially completely excavated burrows in which - despite the combined effort of the whole digging team - no eggs were found are refilled and tamped down with the utmost force. Adult birds are not preyed upon, although man is indirectly responsible for casualties among adult birds due to collision with electricity wires and traffic: during a year, five birds were killed through wires and one by a motorbike.

Snakes

According to De Rooy (1915) (see also: Menzies 1996) the following snakes occur on Haruku: *Python amethystinus*, *Enygrus carinatus*, *Brachyorrus albus* (= *Boiga irregularis*) and *Acanthopis antarticus*. In general, all these species are known to eat eggs and chicks of any bird. The python is also known to prey on adult birds. Of these possible predators of *Eulipoa*, we only observed *Boiga*, *Python* and *Enygrus* at the nesting grounds. *Boiga irregularis* was most commonly seen (mostly specimens measuring 1.5 m) during the night and the early morning hours. They regularly caught chicks at the moment they emerged from the soil (Fig. 39). *Enygrus carinatus* was less commonly seen and was once observed consuming a chick. We once observed *Python amethystinus* at the nesting grounds. According to the local egg-collectors it is a predator of *Eulipoa* chicks but we could not confirm this by direct observation. Although not observed by us, eggs are also said to be taken by snakes. [On North Buru, near the Air Buya nesting ground, we observed estuarine crocodiles *Crocodylus porosus*; according to local information they prey on *Eulipoa*]

Monitor lizards

De Rooy (1917) does not mention Varanidae to occur on Haruku, but we regulary encountered one species at the nesting grounds (*Varanus indicus*) and found proof of the occurrence on the island of an other species: *Hydrosaurus amboinensis*, on Ambon known as 'soa soa layar' (Visser & Van de Koore 1990; Böhme

Figure 39 A brown tree-snake *Boiga irregularis* just after taking a newly fledged *Eulipoa* chick at the Tanjung Maleo nesting ground. [photo: C.J.Heij]

et al. 1994). The latter species is well known on Haruku, locally called 'kidol' but it does not occur at the nesting grounds. *Varanus indicus*, with a length of up to 1 m, locally called 'soa soa', was commonly seen to prey upon both eggs and chicks.

Cats, dogs, rats and pigs

According to local information, feral cats *Felis catus*, feral dogs *Canis familiaris*, wild pigs *Sus* sp. and rats *Rattus* sp. are regulary present at the nesting grounds to forage, and are said to prey upon *Eulipoa*. We could not confirm this for the pig. Dogs were only seen at the bordering beach (and were immediately clubbed to death by the egg-collectors), though are said to prey upon eggs, chicks and adults. We could not confirm this. Rats, most likely *Rattus norvegicus* (see: Flannery 1996), are common in Kailolo Village and we also observed them occasionally at the nesting grounds. Predation on *Eulipoa* eggs and chicks, as is locally known, could however not be confirmed. Wallace (1863) reported the find of a wounded adult female near a freshly dug pit and assumed that the bird had been attacked by a rat. Feral domestic cats are very common in Kailolo Village. They are not fed though, and rely on whatever they can find. We regulary observed them at the nesting grounds, mostly at night. Predation on newly hatched chicks was seen on several occasions and once, at night, a large black-and-white cat tried to catch an adult by jumping in a burrow while about 30 birds were present at the field. The attempt was unsuccessful as all birds immediately flew of f into the surrounding trees. Cats, according to local information, also dig for eggs. We can, however, not confirm this observation.

Birds of prey

Brahminy kites *Haliastur indus*, are daily visitors of the nesting grounds. During daylight hours one or two individuals view the nesting grounds from high trees and act as soon as they spot a newly fledged chick. Actual predation on chicks was seen on several occasions and is also commonly reported by the local egg-collectors. An adult crested hawk *Aviceda subcristata* regulary frequented the forest that surrounds the nesting grounds. The bird mostly kept in the forest edge. We once observed it catching an *Eulipoa* chick in the forest. On several occasions a crested hawk was seen in a low flight carrying a large prey. It could however not be established whether it was a megapode or a dark domestic chicken. The grey hawk *Accipiter novaehollandiae* was an inconspicuous inhabitant of the forest at Tanjung Maleo, but its presence could be revealed regulary by its distinctive call. We expect the grey hawk to prey upon *Eulipoa* chicks that frequent the forest, but could not get it confirmed through direct observation. Ospreys *Pandion haliaetus*, white bellied sea eagles *Haliaetus leucogaster* and spotted kestrel *Falco moluccensis* are common visitors of Tanjung Maleo, althoug they mostly keep well

Table 34 Possible and actual predators of *Eulipoa wallacei* at the Tanjung Maleo (TM) nesting grounds, Haruku Island, observed during the period June 1994 - June 1995. (* = actual, based on local information; @ = actual, confirmed by the authors; ? = possible, observed by the authors; ?? = possible, suspected by the authors; -- = no observations).

		predation on			
predatory species	local name	egg	chick	adult	present at TM
man *Homo sapiens*	orang	* @	* @	--	* @
feral cat *Felis catus*	kucing	*	* @	* @	* @
feral dog *Canis familiaris*	anjing	*	*	*	* @
rat *Rattus* sp.	tikus besar	*	*	--	* @
pig *Sus* sp.	babi	*	*	--	*
brahminy kite *Haliastur indus*	burung jawa	--	* @	* ?	* @
crested hawk *Aviceda subcristata*	wito wito	--	* @	* ?	* @
spotted kestrel *Falco moluccensis*		--	--	--	* @
osprey *Pandion haliaetus*	burung elang	--	--	--	* @
white-bellied sea-eagle *Haliaeetus leucogaster*	burung elang	--	--	* ?	* @
grey hawk *Accipiter novaehollandiae*		--	* ??	--	* @
brown tree snake *Boiga irregularis*	ular patolla	*	* @	--	* @
snake *Enygrus carinatus*	ular batik	*	* @	--	* @
python *Python amethystinus*		*	*	--	* @
monitor lizard *Varanus indicus*	soa soa	* @	* @	--	* @
ant *Solenopsis* sp.	semut merah	--	* @	--	* @

above the trees. Predation on *Eulipoa* was not observed for these tree raptors. A white-bellied sea eagle was seen to prey upon domestic pigeons and once carried a large prey, either a dark domestic chicken or a megapode.

Invertebrates

The only invertebrate predators of *Eulipoa* at Tanjung Maleo were tiny worker-ants belonging to the genus *Solenopsis* WESTWOOD. Chicks that emerged from the soil in a bad condition or chicks whose feathers were still packed in waxlike sheaths and therefore were not yet able to fly, were immediately attacked by these tiny predators. Especially the eyes were preyed upon first. Once invaded by countless ants, the chick has no chance to survive. All dying or freshly dead chicks we found at the surface of the nesting grounds always had numerous red ants around the eyes. Dekker (1990) mentioned chicks of *Macrocephalon maleo* that were killed by *Solenopsis* ants while still in the ground. Field 4 at Tanjung Maleo, situated close to the beach, also housed a large population of (burrow digging) fiddler crabs *Uca* sp. and was regulary freqented at night by (mostly juvenile) coconut-crabs *Birgus latro*. We did not witness any predatory activities on eggs or chicks by these crustacean species and it was not reported by the local people. They are therefore not listed in Table 34. Still there is a possibility that weak chicks be attacked by crabs.

Man against the other predators

The local egg-collectors at Tanjung Maleo are well aware that they are not the only predators. In addition to their activities to protect the area from other human egg-collectors and to keep the field tidy and devoid of invading vegetation, much time is therefore spent to kill their competitors. Dogs, feral or not, are not welcome in this Islamic community and are clubbed to death once they come into sight. Feral cats, although known to take the occassional *Eulipoa*, are not killed. Snakes and monitor lizards, however, are heavily prosecuted. When spotted at or near the nesting grounds they are killed immediately and as soon as traces (foot-prints) of monitor lizards are found, poisoned *Eulipoa* eggs are put out as bait (Fig. 5). During the period June 1994 to June 1995 the following number of snakes and monitors were killed at the nesting grounds: *Boiga irregularis* 21, *Varanus indicus* 18 and *Enygrus carinatus* 7. The eradication of the monitor lizards at Tanjung Maleo could well be the cause of the occurrence of enormous quantities of fiddler-crabs on Field 4.

11 OTHER NESTING GROUNDS

In order to reassess the status of *Eulipoa* nesting grounds known from (mostly old) literature (Table 35) and in order to find new nesting grounds, an extensive survey was carried out in the period September 1994 - April 1995 and in April 1996 and April 1997. All islands known to have nesting grounds or inland habitat where the bird occurs or on which the occurrence is suspected (Table 35), were visited. As a consequence our survey encompassed the entire range of the species. Figure 40 shows the approximate locations of the islands/coastal sites that were surveyed. Table 36 presents an itinerary of the surveys. Trips to other islands than Haruku were always scheduled in such a way that it assured our regular presence at the main study area of Tanjung Maleo. When absent from Haruku, standard observations were carried out by local personnel. During the surveys we were always accompanied by at least one member of the Tanjung Maleo collecting team, in most cases Pede Tuayana, the tenant himself. Their assistance proved to be most rewarding as they could easily make contact with locals and get up-to-date information, and were trained to recognise traces of *Eulipoa*. In contacts with local people, photographs and illustrations of the three megapodes of the region (*Eulipoa wallacei*, *Megapodius forstenii* and *M. freycinet*) played an important role. Nesting grounds were visited both by day and night, mostly in company of local collectors. Table 41 summarizes the results.

Table 35 Primary references of the occurrence of *Eulipoa wallacei* on some Moluccan Islands and Misool.

	island (location)		
author	nesting ground(s)	inland habitat	habitat not listed
Gray (1860) /			
Wallace (1860)	--	--	East Halmahera
Wallace (1863)	North Buru (Wa Pate)	--	Ternate[1]
Van Hoëvell (1875)	Pombo,	--	--
	Kasa	--	--
Salvadori (1882)	--	--	Ambon[1]
	--	--	Seram
	--	--	Bacan
Martin (1894)	Haruku (Tanjung Maleo)	--	--
Stresemann (1914a)	--	Seram (Hatu Sake)	--
Stresemann (1914b)	West Buru (Fogi)	--	--
Siebers (1930)	South Buru (Wa Kasi[2])	Buru (Fakal)	--
De Wiljes-Hissink (1953)	South Seram (Elpaputih Bay)	--	--
	Meti (off NE Halmahera)	--	
Heinrich (1956)	West Halmahera (Gamkonora)	Bacan (Mount Sibela)	--
Ripley (1960)	--	Misool (Tamulol)	--
Jones et al. (1995)	--	--	Morotai[3]
	--	--	Kasiruta[3]
	--	--	Obi[3]
	--	--	Saparua/Nusa Laut[3]

1 natural occurrence sometimes doubted because of trade in birdskins from these islands.

2 and some other coastal sites.

3 possible occurrence, no proof.

Figure 40 The Moluccan Islands (including the bordering Western Papuan Islands) and the approximate locations of coastal sites visited during the surveys (see Table 36). [map graphics: Jaap van Leeuwen Design]

HARUKU ISLAND

Haruku Village

On Haruku Island there is another *Eulipoa* nesting ground, situated just south of the village of Haruku, about 10 km south of Kailolo, south of Fort Nieuw Zeeland. It is a 1500 m long white sandy beach with high parts that do not flood at high tide, grown with some shrub and ivy *Ipomoea pes-caprae*. The southern end of the beach runs into Tanjung Kapal, a high overgrown coral rock jutting out into the sea. The higher areas of the beach, a stretch of about 200 m in length and varying in width, are used as a nesting ground. It is separated into four sandy patches of respectively 50, 45, 400 and 200 m^2. The sand is coarser than in Kailolo. A rough forest area with gardens and stands of coconut trees

Table 36 Itinerary of surveys conducted in search of *Eulipoa* nesting grounds. Visits to Pombo Island and surveys on Haruku Island are not listed, for Buru Island see also Tables 38 & 39.

North Buru: 5-12 September 1994

South Seram: 27 September - 1 October 1994; 2 & 24-26 April 1996
Kairatu, Latu: 27 September, 24-26 April
Iha (Wa Tala): 28-30 September
Amahai: 30 September - 1 October, 2 April

Southwest Seram (Piru Bay): 23-27 October 1994
Kaibobo, Babi Island: 23-24 October
Kasa Island: 25-27 October

West Seram: 30 October - 5 november 1994
Pelita Jaya: 30 October
Waisala: 31 October
Boano Island: 31 October - 3 November
Kelang Island (including Babi Island): 3-5 November

Ambon Island: 12-15 November 1994
Hunimuna, Liang: 12-14 November
Tawiri: 15 November

North Seram: 21-24 November 1994
Wahai (east): 21-22 November
Wahai (west): 23-24 November

South Buru: 2-9 January 1995

Saparua Island, Nusa Laut Island: 17-19 January 1995 March/April 1996

North Moluccas: 22 January - 11 February 1995 & 22 - 28 April 1995
Ternate Island, Tidore Island: 23-24, 28-29 January, 26-28 April
Halmahera Island: Gamkonora, Sidangole 30-31 January
Halmahera Island: Galela: 1-3 February
Halmahera Island: Tobelo, Meti Island: 3-4 February
Morotai Island: 5 February
Kasiruta Island, Bacan Island: 6-8 February
Obi Island: 8-9 February, 22-25 April

Southeast Seram: 13-17 April 1996
Dawan, Bitorik, Kirukut: 13-14 April
Geser Island: 15-17 April

Western Papuan Islands: 4-9 April 1997
Misool Island: 4-9 April 1997

Figure 41 On the edges of the nesting ground near Haruku Village, trees were planted by locals in order create shelter for in-flying adults and fledged chicks. [photo: C.J. Heij, September 1994]

Cocos nucifera borders the beach. A river running parallel to the beach and the forest flows into the sea between the two southernmost nesting fields. East of the river, the area becomes hilly and changes into overgrown limestone rocks with bits of forest and gardens.

Eggs are collected during early morning. At night, adult birds are caught for consumption. Everybody is allowed to collect the eggs: there was no 'sasi' (*contra* Dekker et al. 1995; Argeloo & Dekker 1996). Egg collecting is therefore rather haphazardly and there is no local information available of the number of eggs that are collected. We estimate that about five to seven eggs are harvested per day during the dry season. On one occasion we found, spread over the four fields, a total of 17 burrows of which all eggs had been collected. After collecting one does not refill the burrows with sand, like is done in Kailolo.

Maintenance of the nesting ground is also lacking, and hence vegetation invades the open sandy field. As dogs are accepted by the local Christian community, the area is teeming with these malnourished scavengers, that, no doubt, will prey on adult birds during nesting. Dogs, lack of maintenance and uncontrolled egg-collecting seem to have diminished the number of egg-laying birds. We judge this nesting ground to be minor and egg laying to be more or less regular (Table 41).

Formerly, the Haruku Village nesting ground must have been visited by large numbers of egg-laying birds and still it appears to be suitable to offer nesting possibilities for a large *Eulipoa* population. The nesting ground and the hilly hinterland with forests and gardens on chalky soil, form a nesting habitat and an inland habitat located within close proximity of each other. Mr Eliza Kissya, an inhabitant of Haruku Village, is currently trying to obtain a 'sasi' for the area. To enhance the suitability of the area as a nesting ground he has already planted young trees along the four sandy fields (Fig. 41). If managed properly, a 'sasi' could be favourable to both the birds and the local economy (Kissya 1993).

Recommendations - In order to increase the nesting *Eulipoa* population, we advise that one should prohibit collecting of eggs for the next five years. Besides, the dogs should be eradicated and the consumption of adult birds should stop. Once this has been achieved, only limited harvesting of eggs for local consumption should be allowed. Moreover, 25 or so eggs could be fetched monthly from Kailolo to rebury them at the nesting ground, hoping and assuming that the chicks that fledged will return to lay eggs at the same site. When the egg-laying population has reached a stable level, the egg collecting should be undertaken according to strict rules, a 'sasi' or some other agreement, including an allowance of a certain amount of eggs for the collectors. During the rainy season, when few eggs are being laid, collecting should be totally prohibited or at least one of the fields should be left untouched. This, however, can only be achieved through education, as motivation and good will of the villagers is crucial [7] (see chapter 12).

Other beaches

The island of Haruku has another 2000 m of possible nesting beaches, mainly in the north east between Pelauw and Hulaliu. The remainder of the coast is rocky or grown with mangroves. In between, there are some small stretches of sandy beach (25 - 100 m), in the west between Kailolo and Oma, in the south between Oma and Abora. The uninhabited isle of Molano also has suitable beaches. We have, however, not found any trace of nesting Moluccan megapodes on any of these beaches. In gardens along the coast 1500 m north of Kailolo one or two eggs are collected daily.

[7] Heij has achieved that from January 1997 onwards the nesting ground near Haruku Village has a protected status. A 'sasi' has been applied to both the eggs and birds and in an attempt to enhance the number of egg-laying birds, all collecting activities have been seized. On 21 April 1997 the first 24 *Eulipoa* eggs were transferred from Kailolo to desa Haruku and were reburied at the protected site. Of these eggs 83.3% produced fledglings in July 1997. The average incubation period was 78.5 days (range 75-80) [P. Tuanaya in litt. 1997]. With assistance of the Pattimura University of Ambon each month 25 eggs are scheduled to be relocated (Heij in prep.[a]).

POMBO ISLAND

This tiny islet (1000 x 50 m) is situated in the sea-strait between northeastern Ambon and Haruku (Figs. 32 & 40), and is only a few kilometers away from the Tanjung Maleo nesting grounds. It is surrounded by brilliantly white beaches. Although a nature-reserve since 1973, Pombo has since 1991 become more and more a spot for Ambon youngsters to party and spend the night around large campfires. Fishermen come over to poach coral fish and to collect *Eulipoa* eggs. It has been known as a nesting ground for more than a century (Van Hoëvell 1875; Table 35), however De Wiljes-Hissink (1953) did not find any trace of the bird there in 1948. West et al. (1981) mentioned 20 eggs they obtained from Pombo, but they probably originated from Kailolo (see: Jones et al. 1995).

When one of us (Heij) visited Pombo for the first time on 1 and 2 February 1989, ten burrows and some eggshells were found on the higher northeastern part of the island. He regularly visited the island until May 1992 and stayed overnight several times. The occurrence of *Eulipoa* on Pombo is listed in Table 37.

Pombo was visited again on 19 and 20 August 1994. A population of 10 to 15 feral cats *Felis catus* was present and the open sandy patches at the NE and SW points of the island had been overgrown with grass and planted with small trees (*Casuarina equisetifolia* later replaced by *Ficus repens* and *Cordia subcordata*). Still, five newly dug burrows were found on the SW point and eight on the NE point, although the eggs had already been collected by fishermen. They informed us that they search for digging birds at night and take the egg immediately after the bird has left the burrow. On 23/24 October 1994 we did not find any sign of *Eulipoa*, probably due to the presence of fishermen during the preceding night (huge fires could be seen from Kailolo). On 28 December 1994 16 burrows of which four from the preceding night, were found. Again the eggs had been taken. After 28 December 1994 no new burrows were found. During nightly visits several Moluccan megapodes were seen to fly over, coming from the direction of Seram and heading for Haruku.

Table 37 Observations of *Eulipoa wallacei* on Pombo Island during the period February 1989 - April 1997.

date	observations
February 1989	10 burrows
October 1989	13 burrows
31 October 1990	7 burrows
15 November 1990	no burrows
September 1991	8 burrows
2 November 1991	3 burrows, 1 dead adult female carrying a mature egg
19-20 August 1994	13 burrows
23-24 October	no burrows
28 December 1994	16 burrows
29 December 1994	no new burrows, 1 flying bird
14-15 March 1996	no burrows, 7 feral cats
22 March 1996	no burrows
28 April 1997	no burrows, several flying birds

From these observations we conclude that Pombo island does provide nesting opportunities for *Eulipoa wallacei*, the actual number of egg-laying birds is low and of marginal importance (Table 41). From recent years (1996/1997) there are, however, no more nesting records. Because of its location on the route from Ambon and Seram to Haruku it is of importance to birds belonging to the Tanjung Maleo breeding population. As also indicated by Dekker et al. (1995), Pombo has no distinct population, but is occasionally used by birds from the Tanjung Maleo population. In this respect Pombo can play an important role. The following measures should therefore be implemented by the authorities that manage this official nature reserve:
(1) Restrict the recreation activities to the beach along the center of the island (the grounds suitable for nesting, situated at both ends of the island, will not be disturbed by noise and campfires). (2) Encourage the professional fishermen to fry their catches at the beach along the centre of the island and to leave the eggs alone. (3) Keep out poachers and fishermen. (4) Clean up the beaches so that the island gets more attractive to tourists. Local boat-owners and fishermen will get more income trough transport to and from the island and hence will have no need to poach and collect eggs. (5) Eliminate the feral cats. (6) Stop planting new vegetation at the nesting areas.

AMBON ISLAND

The occurrence of *Eulipoa* on Ambon was first reported by Salvadori (1882) [Table 35], but the natural occurrence of the bird has been doubted by later workers (see Jones et al. 1995) because Ambon, in those days, was a center of bird trade. Since then no more records have become known. During this study, interviews with locals of Ambon Island repeatedly resulted in stories about former nesting grounds being situated between the villages of Liang and Hunimua and on the beach along Ambon Bay near the village of Tawiri. Both sites were visited and searched for traces of *Eulipoa* in November 1994 (Table 36).

Liang and Hunimua

These villages are situated in Northeast Ambon, about 32 km north of Ambon town. The beach is about 1500 m long and 10-15 m wide. The higher parts offer good nesting opportunities. Next to the beach there is dense secondary vegetation with high trees. Some hundred metres towards the southwest, this area changes into overgrown limestone rocks, of which parts are in use as allotment gardens to provide food-crops for the locals. Mount Salahutu (1060 m) lies six km to the south and may, according to Dekker et al. (1995) and Jones et al. (1995), form a suitable inland habitat for *Eulipoa*. We climbed the Salahutu on several occasions, but unfortunately did not find *Eulipoa*. Local guides, familiar with the mountains' wildlife, did not know *Eulipoa* either. It is known, however, that the bird in its inland habitat is an extremely shy and inconspicuous bird: only a handful of field observations are known.

From 1988 onwards, the beach has become a busy recreation area where hundreds of visitors have a good time especially during the weekends. As a result, the beach is covered with garbage which is being gathered into great heaps and set on fire at night. Towards the east, along a stretch of 300 m, the influence of Liang Village and its inhabitants is very prominent. The beach ends at the landing-jetty of the ferry to Seram. Further southeast lies a dirty, neglected stretch of beach (1000 m long, 2-5 m wide) bordered inland by a flat area with low grassy vegetation and open sandy spots. On 12 November 1994, in this area, among the dirt, we discovered 21 fresly dug *Eulipoa* burrows in clusters of 13, 4 and 4. The eggs of the eight burrows we checked, and probably also those in the other burrows, had all been taken, probably the result of collecting by locals and predation by monitor lizards *Varanus indicus*, of which the latter, according to the large number of traces, was very abundant. Numerous large fiddler-crabs *Uca* sp. and two feral cats *Felis catus* were also scavenging in the area. The final 1000 m of beach in southerly direction is absolutely filthy. The fine sand is collected by the lorry-load for the house-building industry. We did not find any sign of *Eulipoa* there. On 14 November 1994 however, on the flat inland area grown with low grassy vegetation, bordered by the beach, we – to our surprise – found a total 30 burrows, four of which were fresh (dug the preceding night). One of the burrows had been emptied by a cat.

Interviews with local elderly people and stories told in Kailolo, revealed that the Liang beach has been a large nesting ground 'in the old days'. As the younger generation does not know *Eulipoa* and its eggs, we assume that they refer to the period about 40-50 years ago. The younger locals do however know *Megapodius forstenii*, and showed us some mounds in the forest along the beach. Currently, Northeast Ambon offers only limited nesting possiblities for low numbers of birds. Nesting activities are most likely incidental (Table 41). Disturbance, especially by nightly burning of garbage, is great. It is however striking that pollution with all kinds of waste-material does not seem to withhold the (few) birds to dig burrows and lay their eggs.

Tawiri Village

The village of Tawiri is situated on the south-western part of the Hitu peninsula along Ambon Bay. The beach, which, according to local information, was formerly used as a nesting ground by *Eulipoa*, lies at the mouth of a river. A picture is to be found in Strack (1993). The beach in question is presently very polluted by waste from the village as well as from the river. The small sandy patches on the higher grounds, the most suitable for nesting, are covered with a layer of 30-50 cm of plastic debris and household waste. Feeding pigs were numerous and no (traces of) burrows were found. Although the older villagers had vivid memories of *Eulipoa* and their eggs, Tawiri beach must have been abandoned by the birds long ago, and current nesting is highly unlikely (Table 41).

SAPARUA AND NUSA LAUT ISLAND

These islands are situated east of Haruku Island and (together with Haruku) form the Lease Islands, which are almost encompassed by the western part of Seram (Fig. 40). Both islands were surveyed from 17 till 19 January 1995 and in March/April 1996 (Table 36). Interviews with locals on both islands revealed that *Eulipoa wallacei* is not known to nest on the islands. Even the oldest inhabitants responded negatively to our questions and photographs, and directed us straight to mounds of *Megapodius forstenii* and advised us to go to Haruku. Indeed, most of the beaches are totally unsuitable as they are flooded by the tide. Some beaches on Saparu appeared to be suitable: south of Haria (200 m), Waihenahia (600 m), Siri Sori (100 m), Tanjung Batuanas (50 m), and Paperu (50 m). However, we did not find any burrows or any other traces of the bird. As far as the inland habitat is concerned, we noticed that most of Saparua's forest has been cut down. The same goes for Nusa Laut. Although Jones et al. (1995) listed Saparua and Nusa Laut as islands of possible occurrence of *Eulipoa* (Table 35), we conclude that the species does not inhabit these islands.

SERAM ISLAND

Salvadori (1882) was the first to report the occurrence of *Eulipoa wallacei* on the island of Seram, although it remained unclear whether the specimens were obtained from a nesting ground or an inland habitat. Stresemann (1914a) found the bird at an inland altitude of 1000 m, and the first report of nesting grounds came from De Wiljes-Hissink (1953) [Table 35]. For reasons of convience we divide Seram in five regions: the South, the Southeast, the North, the West and the Southwest (Fig. 40).

SOUTH SERAM

The area that we define as South Seram is situated between Piru Bay and the eastern end of Elpaputih Bay (Figs. 32 & 40). Our surveys were conducted during the period of 27 September till 1 October 1994 and on 2 and 24-26 April 1996 (Table 36), mainly from the Trans Seram Road that runs for the greater part along the coast. The coastal strip could therefore easily be reached and checked for nesting suitability.

Kairatu and Latu

The coastline between Kairatu and Latu is very rocky and few sandy beaches, or sandy spots situated more inland, are present. Despite that, two small nesting grounds (60 m beach each) were found in April 1996: one on the beach a few kilometers east of Kairatu and one near Latu. We witnessed the collecting of three eggs on each nesting ground, and were told that eggs from these sites are regulary offered for sale (500 rp each) at the Kairatu market. We judge both nesting grounds to be minor and egg-laying to be occasional.

The coastline along the Elpaputih Bay also has a muddy coral substrate with large boulders. There are however some small stretches of black sandy beach. The strip of land between the road and the beach is planted with coconut palms *Cocos nucifera*, whereas some less-cultivated patches are grown with low shrub and screw palms *Pandanus* sp. Both the beaches and the less-cultivated areas are suitable for nesting by *Eulipoa*. Further inland there are limestone hills with secondary vegetation, and further north, at higher altitudes, vast areas of rainforests occur. According to local people, the overgrown limestone hills form the inland habitat of *Eulipoa* (PLATE VIII). Our radio-tracking results (see: chapter 8) confirmed these reports. A local bird-catcher, named Pudé, from Latu Village, told us that he regularly catches adults of *Eulipoa* in the inland area north of Latu at a height of 100-150 m. There, in the densely vegetated limestone hills, he regulary sees the birds forage on the forest floor in rather noisy fast moving groups of 5-10 individuals. Birds were said to be very tasty and he presented us some leftovers from dinner: the feet (now in the collection of the Natural History Museum Rotterdam, nr NMR 9997-00286). According to him, the males do not come down to the beach, which is in accordance with our own observations.

South Seram is known as an *Eulipoa* nesting-habitat from observations by De Wiljes-Hissink (1953) and Dekker (1991). They mentioned the locations Elpaputih and Amahai. The latter site could easily be located (as the name is still in use), but a village or other specific location named Elpaputih was not found and was locally not known as a nesting ground either. Instead, local information pointed towards the villages Samasoeroe ahilatoe, Ahilatoe and Iha, situated along the western side of Elpaputih Bay between the rivers Oewe and Tala. We found the area at 83 road kilometers east of Kairatu. The three villages are merged together and are presently known as Iha Baru (new Iha), named after Iha Village of Saparua Island, from which in 1993 a number of inhabitants transmigrated to this area. As the river Tala is located in the area, we assume that it is the coastal strip as described by De Wiljes-Hissink (1953), see also Dekker et al. (1995).

Iha Village

The area between the rivers Tala and Oewe indeed appeared to be used as a nesting ground.

The beach is 5 - 8 m wide, lies 500 m north and and 500 m south of Iha Village (Fig. 32B) and consists of black sand, stones and gravel. On higher grounds next to the beach there is a flat area grown with coconut palms *Cocos nucifera* and *Pandanus* trees alternating with small gardens where locals grow papaya and kasbi.As they are not flooded at high tide, the sandy patches in the gardens appear to be the most suitable sites for nesting. During our nocturnal visit in company of a local egg-collector who lives on the beach, we observed two burrowing birds and collected three eggs. The egg-depth ranged between 40 and 60 cm. An interview with some egg-collectors yielded the following information: (1) the highest numbers of eggs are collected in September and October, and during the full moon period; (2) both eggs and adult birds are collected and consumed; (3) there isno 'sasi': everyone is allowed to collect eggs; (4) collecting starts at 04.00 h; (5) emptied burrows are not refilled (we found the beach above the high water mark and the gardens covered with old emptied burrows); (6) predatory activities are not known (we did, however, find eggs of monitor lizards *Varanus indicus* and had been warned against crocodiles); (7) the mound-building *Megapodius forstenii* is also known from the area, and its eggs are collected as well.

During our presence, nine eggs were collected in two days. Starting from this number, we estimate that during full moon 8 - 10 eggs are collected daily. The ten-day period around full moon would consequently yield 80-100 eggs. During the rest of the month we estimate the yield to be 2-3 eggs per day, meaning a total of 40-60 eggs. The monthly total for September, when according to local information peak numbers are found, would consequently be 120-160 eggs. Calculated for a year, assuming the 2:1 ratio (2/3 dry season, 1/3 rainy season), as found in Tanjung Maleo, Haruku Island, is applicable, this would mean a total harvest of 960-1280 eggs (720-960 during dry season). As this nesting ground has at least a history of 40 years, we assume that it is in use by a distinct *Eulipoa*-population, and not by birds that incidentally visit the area. Hence, the total population of egg-laying females involved would be no more than 100.
This small nesting ground clearly suffers from human predation on both eggs and adult birds. As no rules governing the egg-collecting nor any maintenance of the nesting grounds occur, we expect *Eulipoa*, through time, will certainly not be able to maintain a breeding population there. Other beaches and sandy patches on higher grounds along Elpaputih Bay seemed suitable for small-scale nesting, however during our survey we found no proof of these areas actually being used.

Tanjung Koako (Amahai airstrip)
This nesting ground was first described by De Wiljes-Hissink (1953). More recently, Dekker (1991) visited the area and established that it was still in use by low numbers of nesting birds. We visited the area on 30 September and 1 Oktober 1994 and on 2 April 1996 (Table 36). The nesting ground is located along an airstrip, 13 km south of Amahai (also known as Masohi) at the eastern end of Elpaputih Bay on a cape called Tanjung Koaka (Fig. 32 B). The airstrip and its margins run parallel to the beach (black sand) but is located at a higher elevation and thus is not flooded. The area suitable for nesting is about 1000 m long and the width varies between 5 and 15 m. It is sparsely grown with secondary shrub, e.g. *Lantana* sp. (Fig. 42). The coarse, pebbly sand is quarried and used for local road construction.

On two occasions we witnessed the collecting of, respectively, 3 and 4 eggs, which, according to local information, is normal for a moonless night in the month of September. During the full-moon period 8 to 10 eggs per day are collected. Other information obtained from locals was: (1) there is no 'sasi', everybody is allowed to collect eggs (we saw it being done by a few young boys); (2) most eggs are collected during the full-moon period; (3) every year the number of collected eggs decreases, although the effort to find them increases; (4) Adult birds are caught and eaten; (5) the eggs are sold for 300-500 rupiah each. (6) egg-collecting is only done during the five month period from September to January. Outside this period the harvest is not worth the effort as only few birds

Figure 42 The *Eulipoa* nesting ground on Tanjung Koako along the Amahai airstrip on the eastern end of Elpaputih Bay, South Seram. [photo: C.J. Heij]

lay eggs; (7) emptied burrows are occasionally refilled. On 2 April 1996 the situation had not changed dramatically. Some fresh burrows were present.

Based on these data the five month egg-collecting season would yield a total of 700-900 eggs (140-180 a month). As in Tanjung Maleo, we expect egg-laying birds to visit the airstrip throughout the year, but in lower numbers (or at a lower rate) during the rainy season. The known 2:1 ratio would mean an annual egg-production of 930-1200 and the number of egg-laying females involved to be about 100. These figures come close to the data obtained from the Iha nesting ground. Likewise, we also consider the Amahai airstrip of minor importance. The fact that eggs are only collected during the period September - January, probably gives this nesting ground a (limited) future: the few eggs laid outside the collecting season have a chance to hatch.

Recommendations - Although the numbers of eggs, according to local information, decreases, this nesting ground could provide nesting opportunities for more birds, when: (1) no trespassing would be allowed on the airstrip and its margins, (2) the area would not be quarried, and (3) the catching of adult birds would stop.

Conclusion

In the South Seram region the future for *Eulipoa wallacei* is gloomy. The human population has increased dramatically after the Trans Seram Road has been opened, meaning more egg-collectors, less ground available for nesting, more sand required for the building industry, more unrest, more noise etc. In addition, the transmigrated people do not respect the old traditions governing the egg-collecting and even consume the adult birds. The inland habitat of *Eulipoa* is also under heavy pressure. Selective logging for timber continues and local transmigrants cut the remaining forest down for domestic use and/or commercial purposes, after which entire areas are being burnt down to make way for gardens. These cash-crop gardens penetrate more and more inland, and in some areas are merged into new plantations growing rubber trees, hybrid coconut-palms and cocoa-shrubs (see also Ellen 1993). In this way South Seram is being cultivated and the habitat of *Eulipoa* and other wildlife is disappearing at an alarming rate.

SOUTHEAST SERAM

A survey of 80 km of coastline along the south-eastern point of Seram (Fig. 40) conducted during 13-17 April 1996 (Table 36), yielded a total of four sandy beaches, each less than a kilometer in length, where we found proof of nesting by *Eulipoa wallacei*. One nesting ground was found on the small of fshore island of Geser (situated between the mainland and Seram-Laut) and three were found on the mainland close to rivermouths near the villages of Dawan, Bitorik and Kirukut. On each nesting ground we found a few freshly dug burrows and witnessed the harvest of 1-2 eggs. According to local information, in the peak season about 3-5 eggs are collected daily and adults are also regulary caught for consumption. We suppose the egg-laying birds originate from the mountainous inland area and judge the nesting grounds to be minor and being used regulary by only a small number of egg-laying birds. These are the first records of nesting by *Eulipoa* for Southeast-Seram (*cf*. Jones et al. 1995)

NORTH SERAM

No *Eulipoa* nesting grounds are known from the north coast of Seram (Jones et al. 1995), although Bowler & Taylor (1989) encountered one adult bird in coastal shrub west of Wahai and assumed it was a female on her way to the beach to lay her egg. This could well be the case, as the coastal strip east and west of Wahai consists of some very fine sandy, sunexposed beaches. We surveyed the area from 21 to 24 November 1995 (Table 36), the town of Wahai being our starting point (Fig. 40). The beaches east of Wahai were surveyed on foot, while the coastline in the western direction was searched for suitable beaches from a dugout-canoe. Every stretch of sandy beach we noticed was then surveyed on foot. The canoe was also used to visit some small, uninhabited of f-shore islands.

Wahai-East: Labuan - Tanjung Sariputih (25 km)

From Labuan Village onwards there is a 5-10 m wide, white sandy beach, bordered by a higher, flat, and thinly vegetated bushy area with open sandy spots. More inland lies Manusela National Park, a vast mountainous area famous for its primary tropical forests. There are no human settlements along the coastal strip (Fig. 43), although some fishermen live on the beach.

The local fishermen know *Eulipoa* well, collect the eggs haphazardly and sell them in Wahai for 300 - 500 rp. According to local information, collecting is mostly done in the dry season (June-September) and during the full-moon period. Adults are not caught. As the nesting ground extends over a 25 km long stretch of beach and most burrows are more or less evenly spread over the area, collecting is very laborious and hence most of the eggs are not found. Still, according to local information, in the dry season during the full-moon period an estimated 100 eggs are collected daily. *Megapodius forstenii* is known from the coastal forest. We found several mounds and locals showed us three collected eggs and a newly hatched chick of this species.

During our survey, five days after full-moon, we encountered four to five burrows on every other stretch of 100 m beach, mostly situated on the higher grounds but also on the beach just above the high-water mark. Clustering-rate was low: most burrows were situated solitarily or in groups of two or three. Most of the burrows

Figure 43 The coastal strip east of Wahai (North Seram) appeared be a nesting ground for a substantial *Eulipoa* population. [photo: C.J. Heij]

were old and emptied, though some were untouched and at least one burrow (per 100 m beach) was freshly dug during the preceding night. Burrows from which the eggs had been taken, were not refilled by the collectors. Around the burrows, we found traces of predation by monitor lizards *Varanus* sp. and by the common palm civet *Paradoxurus hermaphroditus*.

Considering the presence of one freshly dug burrow on every 100 m of beach, we estimate that in the dry season and during the full-moon period, on 25 km of suitable coastline about 250 eggs are laid daily, of which, according to local information, about 100 (40%) are collected. For an entire 10 day full-moon period the production is expected to be 2000-2500 eggs. In the remaining 20 days 1000-1250 eggs are expected to be laid, resulting in a monthly total of 3000-3750 eggs. The four month dry season would yield 12000-15000 eggs, of which 4800 - 6000 are collected. Based on the 2:1 ratio found in Tanjung Maleo, Haruku, the total number of eggs laid during the year at the beach east of Wahai would be 18000-22500. These numbers, although a rough estimate, indicate that a substantial population (at most 1800-2250 egg-laying birds) uses the 25 km of beach as a nesting ground.

Wahai-West: Wahai-Saleman/Saka (40 km)

The 40 km of coastline in a western direction between Wahai and Saka, just beyond the village of Saleman was surveyed. Some small ofshore islands were also visited. The initial 18 km of coastline is fringed with mangroves and some sandy beaches. Inland, these beaches change into gardens with coconut palms and shrubbery. Further inland there are hills grown with secondary forest and some remnants of primary rain-forest. The rocky points jutting out into the sea are overgrown with *Lantana* sp. and *Pandanus* sp. No burrows were found on these beaches, despite the apparent suitability.

However, more towards the west along the beach of Saleman Bay we found 76 clusters, each consisting of 2 to 5 *Eulipoa* burrows, over a distance of 5 km. About 80% was old and the remaining 20% was dug the previous night. Near Roho Village some fresh burrows had been emptied by local egg-collectors that very morning. There we also found fresh egg shells. Local information indicated that about 3 to 5 eggs are collected daily and that adult birds are not captured. Eggs are sold for 300-500 rp each.

Around the burrows near the river Ika we found traces of predation by monitor lizards *Varanus* sp., common palm civets and a crocodile. Brahminy kites *Haliastur indus* were common. Further to the west we visited other suitable looking stretches of beach; in all cases each 50-150 m of beach yielded 1-2 fresh burrows and 2-5 old ones. There, no traces of egg-collecting were found. West of Saka many kilometers of beach and an increasing number of villages could be seen. The hilly inland area was grassy and devoid of trees, a habitat type not known to be suitable for *Eulipoa*.

The beaches of the small offshore islands of Sapalewa, Casuari, Sawai, Hatuwe and Rajah all appeared to be used regulary as nesting grounds by small numbers of *Eulipoa*. Sapalewa for example, which we rounded in seven minutes, housed 35 old and 3 freshly dug burrows. On Rajah we found some burrows surrounded by holes of fiddler crabs *Uca* sp. (average 5 to 6 crab holes per m^2), indicating little chance for survival for newly hatched chicks. As no drinking water is found on these islands, they are uninhabited. The only humans that occasionally frequent the islands are fishermen drying their catch. Human egg-predation is therefore low.

Conclusion

In North Seram, a large part of the 65 km of sandy beaches west and especially east of Wahai and the beaches of small offshore islands are in use as nesting grounds. Egg-laying along these beaches lacks the massive communal character as present at Tanjung Maleo: single burrows and small clusters are more evenly spread over large stretches of beach. But total numbers of eggs probably come close to those of Tanjung Maleo. As the area is thinly populated and egg-collecting takes place from villages, only a limited percentage (maximum 20-40 %)

is collected. Numerous stretches of beach are seldomly visited by humans. Therefore, the beaches, the partly overgrown flat areas bordering the beach, in combination with the inland forest, form an very suitable habitat for a substantial *Eulipoa* population.

WEST SERAM

The coastline of West Seram appeared to be either fringed with mangroves or very muddy and hence not suitable for nesting by *Eulipoa*. Therefore, we surveyed the nearby islands of Boano, Babi and Kelang (Fig. 32A). Both dug-out canoes and a motorvessel stationed at Pelita Jaya and Waisala Village were used to search for suitable beaches. The survey was carried out in the period 30 October - 5 November 1994 (Table 36).

Boano Island

Although we surveyed the entire coastline of Boano (see also Moeliker & Heij 1995) we only found traces of the presence of *Eulipoa* along the western beaches. Both old and freshly dug burrows were found at the white (coarse coral-sand) beaches situated in the southwestern entrance of the narrow Strait Valentijn and along the beach further south near Anauni Village. On the latter beach (10-15 m wide) we counted 18 burrows (including 3 freshly dug) more or less evenly spread over a stretch of 200 m. Locals from Anauni Village informed us that eggs are occasionally collected. The small offshore island of Sendiri, Kelapa and Kasuari also appeared to have suitable nesting beaches, although we did not find burrows.The rugged and overgrown limestone landscape of the interior does seem to be a suitable inland habitat for *Eulipoa*. In forests bordering sandy beaches along the entire coast, mounds of *Megapodius forstenii* were abundant. In one specific strip of forest, measuring 200 x 50 m, we found a total of six huge mounds. The birds themselves were also regulary observed.

Babi Island

This narrow island forms a bridge between the mainland of Seram and Kelang Island. The interior is flat and consists of secondary forest and shrub. The entire northern coastline (4-5 km) is sandy and suitable for nesting, although at extreme high tides the entire beach will be flooded. We checked a stretch of 200 m and found 31 burrows, of which 8 were freshly dug.

Kelang Island

The coastline of this island consists of a narrow flat area bordered by limestone rocks that rise steeply towards a height of 500 m. The rugged rocky inland area holds secondary forest, shrub and some high trees. On the coastal plain, there are numerous villages and food-crop gardens. Most beaches on the east and south coasts consist of pebbles and hence are not suitable for nesting. The western and northern coasts have some kilometers of sandy beach on which we found some scattered burrows. Local information revealed that *Eulipoa* eggs are not systematically harvested. Local fisherman and wandering Butonese people that frequent the beaches are said to collect eggs regularly. No eggs were offered for sale.

Seen from a distance, the white beaches of Manipa Island, and of about 10 tiny offshore islands situated to the southwest of Kelang, appeared to be suitable for nesting. The rough sea, however, prevented us from making the crossing.

SOUTHWEST SERAM (PIRU BAY)

Van Hoëvell (1875) and Martin (1894) mentioned the uninhabited Kasa Island, situated in the Bay of Piru (Fig. 32B) as a large nesting ground of *Eulipoa wallacei* (Table 35). These reports, dating back a century, asked for a new assessment of the breeding population. We surveyed the Piru Bay area from 25 till 27 October 1994. In addition to Kasa, we also visited Kaibobo Village and Babi Island (Table 36).

Kaibobo Village

On Ambon and Haruku it is told that *Eulipoa* lays eggs near the village of Kaibobo, south of Piru (Fig. 32 B). A brief visit made clear that there are no possible nesting sites and that the bird is not known from the mainland. Locals directed us to the nearby Babi Island.

Babi Island

This small rocky island with over grown hills is located a few hundred metres south of Kaibobo (Figs. 32 & 40). The vegetation consists of old trees and neglected coconut palms and also pineapple plants. The coastline has mangroves, rocky outcrops and white beaches. Most of the beaches consist of coral and coarse pebbly sand. Due to the lack of drinking water the island is uninhabited, although fishermen frequently visit the island and during the weekend villagers from Kaibobo come over to picknick. The Protestant church has a 'sasi' governing the harvest of pineapples and coconuts. The stretches of beach which form suitable nesting grounds, have a total length of 2000 m and are 3 to 5 m wide. Inland, there are small, partly grown sandy fields which are suitable. A walk around the island over the beaches, searching for traces of *Eulipoa*, yielded 10 old and 3 freshly dug burrows. None of the burrows contained eggs, which according to local fishermen is the result of occasional collecting activities. Emptied burrows are not refilled. Other possible predators we encountered were a single feral cat *Felis catus* and numerous monitor lizards *Varanus indicus*. At night (23.00 p.m.), one adult *Eulipoa* landed next to our campsite on the beach, did some digging at the surface and took off after five minutes in a southerly direction. Several mounds of *Megapodius forstenii* were found and their loud calling was heard throughout the night.

We believe Babi Island is of minor importance. The beaches are suitable, but they are probably only used occasionally for nesting. Birds on their way to other nesting grounds, might use it as a place to rest.

Kasa Island

This small island is situated south of Kaibobo (Fig. 32B). From Babi Island it takes 20 minutes by motorized canoe to reach it. It is a totally flat island surrounded by white (coral) sandy beaches. The interior is grown with shrubbery and *Casuarina* trees. The island is not inhabited, there is no agricultural activity. The eastern end holds a working lighthouse. The northern and southern beaches are on average 15 m wide and get partly flooded at high tide. We rounded the entire island on foot in 2.5 h and estimated 2000-3000 m of beach to be suitable for nesting. The inland area behind the beach, partly grown with succulents and high trees, has some open (coarse pebbly) thinly vegetated sandy fields, where we counted at least 200-250 both old and freshly dug burrows. The northern beach only contained 10 old burrows and two fresh ones from which our collectors took both eggs for dinner. During nightly observations we did not see any *Eulipoa* flying in or digging at the beach. Just before dawn we observed several *Megapodius forstenii* foraging at the edge of the forest. A total of 11 mounds of this megapode species was found.

The island is visited regularly by Butonese fishermen, who come to collect *Eulipoa* eggs (about 30 a day, according to local information) and to catch adults of *M. forstenii* (personal observations). After unearthing the eggs, the burrows are not refilled. Other predatory species that frequent the island are the osprey *Pandion haliaetus* (one nest containing two chicks) and the white-bellied sea eagle *Haliaeetus leucogaster* (one nest containing two chicks). No traces of predation on *Eulipoa* were found: only fish remains were found under both nesting trees.

Given its isolated location in a thinly populated area (implying limited egg-collecting), and for the suitable grounds for nesting both at the beach and in the inland area, we conclude that Kasa Island is of great importance to *Eulipoa wallacei*. Although we did not witness large scale communal nesting activities, the number of burrows we encountered and the local report of the number of eggs being collected, indicate that a substantial number of birds use the island for nesting. If birds from the mainland around the Piru Bay area also fly to the nesting grounds of Haruku, then Kasa - located about half-way on the shortest route - probably also functions as a stop-over resting place. The island, however, has no suitable habitat and is too small to hold a resident *Eulipoa* population.

Recommendations - We recommend a protected status involving permanently stationed guards to prevent egg-collecting and poaching. Compared to Pombo Island, which is situated in the very densely populated Ambon area, this should be an easy, but rewarding task.

BURU ISLAND

Buru is a large island (9000 km^2) situated west of Seram (Fig. 40). The human population density is low (7 per km^2), although most of the settlements are concentrated along the coast. Inland villages depopulate at a high rate. Buru's interior is mountainous and still has substantial forest areas. The first report of the presence of *Eulipoa wallacei* on the island came from A.R. Wallace, who collected a female near Wa Pate on the north coast in 1861 (Wallace 1863; Table 35). Subsequently, Stresemann (1914b) reported a specimen obtained by Denninger in 1906-1907 near Fogi on the westcoast. Siebers (1930) noted that in 1920 the species had totally disappeared from the western beaches, but he discovered nesting grounds along the south coast near the rivermouths of Wa Kasi, Wa Turen, Wa Kuma and Wa Tina (Wa=river). However, compared to previous local reports, the number of egg-laying birds had strongly declined and some sites were no longer in use. Further east along the south coast from Wa Msisi to Wa Tawe, Siebers (1930) found no other nesting grounds, although he collected a female bird from inland Fakal. Presently, reports of *Eulipoa* are rare. Jones & Banjaransari (1989) observed an adult bird in the inland area of Wafawel, but Jepson (1993) found no trace of the bird despite an extensive ornithological survey.

We surveyed the northern and southern coast-line during two separate occasions. North Buru was visited during 5-12 September 1994 by motorbike and on foot (Table 38). South Buru was visited during 2-9 January 1995, due to a lack of roads, by motorized canoe and on foot (Table 39).

Local inhabitants of coastal villages were familiar with megapodes and their nesting habits. They immediately pointed out the right species when shown photographs or illustrations, and proved to be an important source of information concerning past and present status of nesting grounds. The occurrence of two megapode species on Buru (*Eulipoa wallacei* and *Megapodius forstenii*), each having different nesting habits, is fully understood. The mound of *M. forstenii* is called 'benteng', meaning 'fortress' (on Haruku known as 'rumah', meaning 'house').Collecting *Eulipoa* eggs appeared to be a well-known practice. In most villages, both along the north coast and south coast, a daily harvest of 5-8 eggs per day is considered to be many, whereas stories from the past ('the good old days') always mentioned much higher numbers of eggs.

NORTH BURU

All localities where we found proof of present nesting or where local information indicated occurrence of nesting in the past, are listed in Table 38. The following localities still house a fair amount of egg-laying birds and are briefly discussed below.

Lamalang Village - Wa Plau

About halfway between the village Lamalang and the mouth of the river Plau, a 2 km long beach consisting of coarse sands is used as a nesting ground. The total width of the area is about 18 m, divided in 8 m beach and a 10 m wide flat area of shrubbery and small trees (*Euphorbia* sp., *Eucalyptus* sp.) with dry sandy patches and a path. We contacted two local egg-collectors. They informed us that: (1) only two persons collect eggs, (2) August is the peak month, i.e. a maximum of 10 eggs is collected daily, (3) during full moon harvest may reach 15 eggs, (4) eggs are collected throughout the year, however, not daily, (5) fledglings are regulary observed, (6) formerly many more eggs were harvested, (7) adults are caught with snares and consumed.

During our nightly visit, in company of the local collectors, we observed one adult bird and found one fully developed newly hatched chick, weighing 79 g. No fresh burrows were found, from one old burrrow an egg was taken. Most old burrows were located in the sandy patches bordering the beach. The previous night had yielded seven eggs (for weight data see chapter 6). A crested hawk *Aviceda subcristata* and an osprey *Pandion haliaetus* were seen at the beach at sunrise.

The relatively large size and elongated shape of the area, together with a limited number of locals involved in the collecting of eggs, probably result in a fairly good breeding success. The low number of eggs collected is probably not due to a low number of egg-laying birds, but the result of limited collecting activities. As we witnessed, most of the searching for burrows takes place alongside the path, whereas the remaining area is mostly left alone. However, the collecting of adult birds for consumption is, clearly , not favourable.

Table 38 Itinerary of the North Buru survey (5-12 September 1994) with remarks on the presence and status of *Eulipoa* nesting grounds according to local information and/or based on personal observations. (km = distance from Namlea Town by road; Desa = village; Wa = river; -- = no present egg-laying (pers.obs.)

site	km	remarks
Namlea Town	0	On the Namlea market a small number of eggs (15-30 per day) is offered for sale during the first months of the year (loc.info); presently no eggs for sale (pers.obs.)
Desa Lala	7	-- , formerly 'many' eggs (loc.info)
Desa Ubung	11	-- , formerly present (loc.info)
Desa Merasa	17	-- , formerly present (loc.info)
Desa Mitin	21	-- , formerly present (loc.info)
Desa Sawah	23	-- , formerly present (loc.info)
Wa Peran	24	-- , formerly present (loc.info)
Lamalang/ Wa Plau	37 43	formerly many eggs were collected (loc.info), presently limited collecting, 5 eggs/day (pers.obs.), minor, but probably stable population (see text)
Wa Ura	57	formerly 'many' eggs (loc.info), presently only some irregular nesting (pers.obs.)
Sama Lagi Laut	59	-- , formerly present (loc.info)
Wa Putih	75	-- , formerly present (loc.info)
Wa Kose WWI/ Wa Pait/ Wamlana/ Wa Pure	84 89 93 105	10-15 eggs are collected daily (loc.info), nesting ground of moderate importance (pers.obs.) see text
Air Buya	113	up to 15 eggs are collected daily (loc.info), minor nesting ground, declining through uncoordinated collecting of both eggs and adults (pers.obs.) see text
Wa Kasi Utara	128	formerly 'many eggs', bird is still well-known (loc.info), presently every now and then an egg (pers.obs.)
west of Wa Kasi Utara	> 128	--, no more local reports (Wa Tina could not be reached)

Wa Kose (WWI), Wa Pait, Wamlana, Wa Pure

In this area, situated between 84 and 105 km from Namlea, at the mouth of the Wa Nibe (river), close to the WWI plywood factory (Wa nibe Wood Industry), a coastal strip of about 15 km length is used as a nesting ground. The beach consists of coral stones and pebbles. The neighbouring higher grounds are 50-80 m wide, consist of coarse sand and are partly grown with ivy *Ipomoema pes-caprae* and kenari trees *Canarium commune*. Most of the egg laying takes place on sandy parts of the higher grounds. More inland lies the plywood factory with storages, offices and a village for personnel. As most of the area belongs to the factory, only limited access is allowed. The factory village has one egg-collector. Every night he leaves for the beach at 23.00 p.m. and walks for three hours in a westerly direction (±12 km), always looking for digging birds. While we accompanied him on his nightly walk, he informed us that (1) he collects an average of 10-15 eggs per day, (2) during the past 'puasa' (Muslim fasting) in March/April he collected 700 eggs per month, (3) in September, October and November many newly hatched chicks are found, (4) the eggs are sold locally for 300 rp each, in the peak season they are sold on the market in Namlea for 500 rp each, (5) adult birds are not collected and unearthed hard-set eggs are carefully reburied.

This area, with no free access and with just one single collector, holds a fairly large egg-laying population and is better off that the Wa Plau area. Although eggs are gathered daily, the adult birds are not captured and even hard-set eggs are reburied. This makes the Wa Kose (WWI) area a medium sized, important nesting ground.

Air Buya Village

This village is located east of the river Wa Pura, about 113 road kilometers from Namlea. The beach and the bordering higher grounds consist of coarse to very coarse sand mixed with coral stones. The higher grounds are partly overgrown with low shrub, screw palms *Pandanus* sp. and neglected coconut palms *Cocos nucifera*. Although many people occasionally take an egg, there is a local egg collector, living in a shed on the beach, who collects daily. He informed us that (1) the maximum number of eggs he collects per day amounts to 15, but is mostly lower, (2) when unearthed, hard-set eggs are reburied in the same burrow, (3) emptied burrows are not refilled (also pers.obs.), (4) maximum burrow depth is 60 cm, (5) adults are caught and consumed, (6) egg-price is 300-500 rp a piece, depending on demand.

We inspected the nesting ground and the harvest of the morning (6 eggs). Indeed, after collecting the burrows are not refilled. The information on egg-depth could not be checked, old burrows had an average depth of 40-50 cm. Taking into account the rather crowded village, the absence of any rules regarding the collecting of eggs (everybody collects) and the fact that adult birds are also taken, we expect this minor nesting ground to vanish soon. In the vicinity of the nesting ground we observed estuarine crocodiles *Crocodylus porosus* that, according to local information, occasionally prey on *Eulipoa*.

Conclusion

Tables 38 & 41 summarize the present status of nesting grounds along the north coast. Our survey established that most of Buru's northern sandy coastal strip is (or has been) suitable for nesting. Also local information pointed out that *Eulipoa* used to nest along the entire coast. Presently, however, the first 37 km from Namlea Town in a westerly direction holds no more nesting grounds. This is due to the growing number and size of villages, resulting in heavy pressure on the higher sandy grounds. Also the road which is in reasonable shape, eased human exploitation of the area. Further to the west, where the distance between the villages is larger, the density of the human population is lower and the coastal strip is less accessible. Nesting grounds – mostly situated at the partly grown sandy strip bordering the beach – are still in use by a reasonable number of birds. Nevertheless, at all coastal sites, local information clearly indicated that only one or two decades ago, the numbers of egg-laying birds used to be much higher. With roads being improved and new settlements being built, pressure on these areas is still increasing. Destructive activities in the hinterland, like logging and burning also considerably reduce the survival chances of *Eulipoa*. We expect the bird to be almost vanished from the beaches of North Buru within a few decades.

SOUTH BURU

All localities where we found proof of nesting by *Eulipoa wallacei* are discussed below. Tables 39 & 41 summarize the results of our South Buru survey.

Wa Kuma, Wa Wawal and Wa Kasi

At the mouths of these rivers there is a 8 km strip of beach bordered by a 25 m wide, higher situated beach-bank which is partly grown with ivy *Ipomoea pes-caprae*, *Spinifex* sp., *Pandanus tectorius* and alang-alang *Imperata nucifera*. The nesting grounds are mainly situated on the higher sandy banks along the rivermouths (Fig. 44). The boundary of this area is formed in the east by the Bobo mountains and in the west by the Wa Kuma Delta. The area is very thinly populated. The hinterland has been cut down, burned and planted with clove trees *Eugenia aromatica*. According to local information: (1) a total of 12 - 20 eggs is harvested daily, mostly between 23.00 p.m. and 04.00 p.m.; (2) adult birds are also being caught; (3) there are no rules: everyone collects eggs, and (4) after collecting, burrows are not refilled. During our visit to the area we found a large number of burrows, mostly old and in clusters of five to ten. We found traces of monitor lizards, snakes and dogs at the nesting grounds. This nesting ground was discovered in December 1921 by Siebers (1930) who found burrows 'everywhere'.

Wa Bobo, Wa Turen and Wa Haka

This coastal strip of 10 km, located between the mouths of the rivers Bobo, Turen and Haku has a rocky coastline and a very low human population density. Only the rivermouths have sandy beaches which partially flood at high tide. We estimated a total beach-length of 1 km suitable for nesting (Fig. 45). During our survey we

Figure 44 On the coastal strip between the mouths of the Wa Kuma, Wa Wawal and Wa Kasi (South Buru), *Eulipoa* burrows were mainly found on the higher sandy banks along the rivermouths. This photo features the river Kasi (right) running parallel to the beach that is partly grown with *Ipomoea pes-caprae*. One burrow is visible in the centre. [photo: C.J. Heij]

Figure 45 On the coastal strip near the mouth of Wa Bobo (South Buru) some old *Eulipoa* burrows were found in sandy patches between *Spinifex* vegetation. [photo: C.J. Heij]

found a total of about 20 old burrows, mostly in clusters of 4-6. No fresh burrows were found. We did not encounter any indication of egg-collecting by locals. Siebers (1930) received eggs from this area on several occasions.

Wa Mala Village - Ewiri Village

This 2 km coastal strip between Wa Male and Ewiri consists of black sand. The higher situated parts of the beach are grown with ivy. Within this area a sandy field of about 500 x 1000 m is being used as a nesting ground. We found both old and fresly dug burrows in a 1:1 ratio. The locals could not provide us with data on the numbers of eggs. We suspect the numbers to be substantial as almost every villager showed us their daily harvest. Their collecting method – carried out at night – is rather unconventional: birds are blinded by torch-light whilst laying eggs and subsequently both the bird and the egg are taken. We also found traces of monitor-lizards and saw feral dogs roaming around.

Wa Tina and Wa Fusi

The 2.5 km of beach between the mouths of the rivers Tina and Fusi, situated west of Namrole Village, consists of big pebbles and has a small beach bank. The inland area is marshy and grown with *Pandanus* trees. The higher sandy grounds bordering the beach are overgrown with ivy. According to the village chief, who accompanied us, the entire area used to be a good nesting ground. However, in the past few years, the sandy beach has become a pebble beach and most of the area is not suitable for nesting any more. We found 20-30 old and new burrows, amongst which four were dug during the previous night. According to local information, (1) during the full-moon period 10 to 20 eggs are gathered per night, (2) eggs fetch an average of 350-500 rp each, (3) adults birds are not collected, (4) two women are in charge of egg-collecting, they gather each morning. We expect declining numbers of egg-laying birds. Siebers (1930) found only five burrows near the mouth of the river Tina and mentioned local reports that the numbers were much higher some decennia earlier. According to Siebers (1930) the vicinity of a densely populated village had reduced the numbers.

Namrole Airstrip

During construction of the airstrip, much sand has been transferred and, according to local information, much of the area suitable for nesting has disappeared. However, we still found a number of old and new burrows in the newly created sand-piles on a coastal strip of 500 m. The birds apparently still occasionally frequent the area but we believe it depends on the intensity of the use of the airport, whether the local *Eulipoa* population stands a chance at all.

Oki-Baru, Oki-Lama, Tanjung Pohonbatu, Tanjung Salia, Wa Msisi

This coastal strip of about 20 km is situated between the villages of Namrole and Oki. We walked the entire stretch of beach and established that it mostly consisted of fine pebbles, coarse pebbles and rocks. Due to the pebbles the beach was difficult to walk on and most likely not suitable for nesting. Only on the black sandy parts we found proof of nesting activities of *Eulipoa wallacei*. These areas were located between Oki-Baru and Oki-Lama, and Oki-Lama near Tanjung Pohonbatu.

Oki-Baru - Oki-Lama: On this stretch of 5 km black beach we found many burrows (mostly in clusters of 4-7) and calculated an average density of 40 burrows per 1000 m. We also found burrows between the roots of trees on the higher grounds bordering the beach. According to local information everybody gathers eggs, but the adult birds are not collected. We were offered six eggs, their average weight was 102 g. Due to intensive collecting we expect declining numbers of egg-laying birds.

Oki-Lama (Tanjung Pohonbatu): On the higher parts of this black beach (length 5 km) with coarse sand we found about 100 burrows per 1000 m, mostly in clusters of 4-8 burrows. Some fresly laid eggs could be unearthed by our collector. The inland area has a very low human population density and the once densely forested hills are now denuded and grown with alang-alang grass and partially planted with clove trees. On the higher beach grounds, near the burrows, we found many traces of snakes and monitor lizards. Due to the absence of nearby villages, egg-collecting activities are probably few and irregular (we did not witness collecting). We expect the number of egg-laying birds to be stable.

Wa Msisi - W a Tawa

This coastal strip of about 40 km between the mouths of the rivers Msisi and Tawa largely consists of beaches covered with big pebbles and are thus totally unsuitable for nesting. Siebers (1930) did not encounter any nesting grounds in this area. Near the mouth of the Wa Naka river we found 2 km of sandy beach with about 20 burrows. Further , near Kaya Putih Village there is about 1.5 km of suitable beach. There we even found burrows that had been dug almost horizontally into a steep beach-bank (Fig. 46). According to local information, (1) during the full-moon period 20-30 eggs are collected daily, (2) birds only lay during the rainy season, (3) eggs fetch 400 rp each, and (4) formerly more birds visited the area for egg-laying. We estimated the average number of eggs at 20 per night. Just past Kaya Putih Village is the mouth of the Wa Teba river. There we found about 20 (mostly old) burrows on the 1 km of sandy bank between the sea and the river running parallel to it. In this coastal area many traces of snakes and monitor lizards were found. In the vicinity of villages domestic cats and dogs were common.

Conclusion

Our survey in South Buru established that about

Figure 46 Near Kaya Putih Village (South Buru) a steep beach bank contained *Eulipoa* burrows that were dug almost horizontally. [photo C.J. Heij]

Table 39 Nesting grounds of *Eulipoa wallacei* encountered during our survey of South Buru (4-9 January 1995), with notes on beach-length suitable for egg-laying, numbers of eggs that are harvested and remarks on the importance of the nesting grounds (see Table 41). [20/1000 means 20 burrows per 1000 m beach]

nesting ground	suitable beach length in km	egg-harvest	remarks
Wa Kuma, Wa Wawal, Wa Kasi	8	12-20 daily	moderate importance; declining numbers
Wa Bobo, Wa Turen, Wa Haka	1	none	only old burrows found; 20/1000m
Wa Mala - Ewiri	1-2	substantial	minor importance; heavy collecting; probably declining
Wa Tina, Wa Fusi	2.5	10-20 daily	minor importance; declining numbers; beach gets pebbly
Namrole Airstrip	0.5	occasional	marginal importance; area destroyed
Oki Baru-Oki Lama	5	substantial	moderate importance; heavy collecting; declining numbers; burrows: 40/1000m
Oki Lama (Tanjung Pohonbatu)	5	occasional	moderate importance; probably stable; few or no collecting; burrows: 100/1000m
(Wa Msisi - Wa Tawa) Wa Naka	2	unknown	marginal importance; burrows: 10/1000m
Kaya Putih	1.5	20 daily	minor importance; declining numbers; heavy collecting
Wa Teba	1.5	unknown	marginal importance; occasional nesting; burrows: 20/1000m

30 km (20%) of the 150 km of coastline is suitable as a nesting ground for *Eulipoa wallacei* (Table 39). These scattered sandy beaches offer nesting opportunities for a fair amount of birds. The nesting grounds mentioned by Siebers (1930) Wa Turen, Wa Kasi and Wa Tina, are still in use. In addition to these localities, many more small nesting grounds were discovered. Local information, however, clearly pointed at a substantial decline of both suitable nesting grounds and numbers of egg-laying birds. Causes of the decline are no doubt the over-exploitation of the nesting grounds (at most sites both eggs and adults are consumed) and the loss of habitat in the inland area. Logging in the interior still continues and the coastal hills have been denuded and are now grown with alang-alang grass or planted with

clove trees. Although this situation is far from favourable, we believe that as long as the number of coastal settlements does not increase and the inland area is not completely denuded, *Eulipoa* still stands a fair chance of surviving in South Buru. If pressure on the coastal and inland habitats continues, we expect the species to vanish from the nesting grounds within a few decades.

THE NORTH MOLUCCAS

It was the island of Halmahera (formerly called Djailolo or Gilolo) where A.R. Wallace discovered the Moluccan megapode as a species new to science. On this matter, he wrote a letter, dated 22 October 1859 while staying on Ambon Island (Wallace 1860): – 'I have just packed up a large collection of Gilolo and Ternate birds, as well as those from Manado. The former are a much gayer lot, comprising a fine series of *Pitta maxima*, a new *Megapodius*, I think, handsomely banded on the back…' –. The type-locality is known as 'East-Gilolo' with no indication of the exact location (Gray 1860, Robert P. Prys-Jones in litt. 1996). So whether Wallace got his two specimens from a nesting ground (most likely) or an inland area, remains unknown. Further old reports of the presence of *Eulipoa* on Halmahera and neighbouring North Moluccan Islands came from Wallace (1863, 1869) and Von Rosenberg (1878): Ternate Island; Vorderman (1889): Sidangoli, NW-Halmahera; De Wiljes-Hissink (1953): Meti off NE-Halmahera; and Heinrich (1956): Gamkonora, NW-Halmahera and Bacan Island. More recently Heij (1995a) and Dekker et al. (1995) reported on the status of the Galela nesting grounds (NE-Halmahera). Bacan Island is only known to house *Eulipoa* in the mountainous inland habitat (Heinrich 1956, Lambert 1994), nesting grounds are not reported. Jones et al. (1995) listed the islands of Morotai, Obi and Kasiratu as areas of possible occurrence (Table 35).

During our survey of the North Moluccan Islands, carried out in the periods 22 January-11 February 1995 and 22-28 April 1995 (Table 36), we focussed on the locations mentioned above.

TERNATE AND ADJACENT ISLANDS

Repeated visits (Table 36) to the volcanic Ternate (Fig. 40) and the neighbouring islands of Tidore, Waitara, Mare, Matie and Makian, estabished that *Eulipoa wallacei* does not occur there any more. Although the wide black sandy beaches sparsely grown with ivy and low shrub located near river mouths appear extremely suitable for nesting, not a single trace of nesting-activities has been found. Local information also indicated the total absence of *Eulipoa* both at beaches and in the inland habitats. To see the bird, we were always directed to East Halmahera.

HALMAHERA ISLAND

Gamkonora

In Northwest Halmahera, in the area of Sidangoli and Gamkonora (Fig. 40) we encountered a stretch of 14 km suitable sandy beach (partly covered with low vegetation) between the mouths of the rivers Gamkonora and Tahafo. Villages along this 30-40 m wide beach are called Bataka, Tahafo, Loloda and Ibu. The area bordering the beach consists of food-crop gardens and further inland mountain forests rise to an altitude of 1500 m. The rivers are fringed by mangroves. Local inhabitants of this area are very familiar with *Eulipoa*, both on the beach and in the mountainous inland area.

Near the villages of Loloda and Ibu we searched a stretch of 5 km beach-bank with an average width of 40 m, partly grown with *Ipoema pes-caprae*, *Pandanus* sp., *Cuscuta* sp. and *Spinifex littoreus*. There we found a total of 11 clusters, averaging four burrows each. Six burrows had been dug the previous night and from these two eggs were collected. According to local information, (1) during the full-moon period many eggs are laid and everybody goes to the beach to collect, (2) then, on average one finds one egg per 4-5 clustered burrows, being a total of 6 eggs, (3) during the new-moon period one collects only 1-2 eggs per day, (4) adult birds are also caught and consumed, (5) the eggs fetch 250 rp each, (6) collected eggs that appear to be hard-set are reburied in the same burrow, and (7) in the mangroves crocodiles occur (a possible predator). On the nesting ground we found traces of monitor lizards, snakes, cats and dogs. The brahminy kite was common.

Based on the above local information and our burrow count, we come to the following egg-collecting figures for the 5 km beach: 1080 eggs in the six month dry season; 270 in the rainy season; total annual harvest 1350 eggs. The entire area of 14 km between the river mouths would yield about 4000 eggs per year , indicating that the importance of this nesting area is ranked between minor and moderate (see Table 41). Due to intensive collecting we expect declining numbers, but earlier reports on the Gamkonora nesting grounds (Heinrich 1956) and more recently Dekker et al. (1995) gave no estimates of the numbers of birds or eggs.

Galela

This nesting ground, located about 2 km north of Galela Town in Northeast Halmahera (Fig. 40), is a stretch of black sandy beach (Fig. 47) with a total length of 7 km and an average width of 40 m (total surface 28 ha). The beach, which is very sparsely grown with low shrub, is situated in front of a creek fringed with mangroves. As a consequence, the entire nesting ground is surrounded by water and can only be reached by canoe. The area is divided into two parts by the Tiabo River. We got the first report about the ongoing existence of this nesting ground already on 5 February 1990 in Tobelo Town (NE Halmahera) when we were offered *Eulipoa* eggs that originated from Galela. Five years later, in February 1995, we actually encountered the birds and their eggs there.

From conversations with local people, it became clear that several inhabitants of the villages (dusuns) situated behind the beach and the mangroves possess a stretch of beach to collect eggs from. The ownership of each beach-plot is passed on from father to son. One of the plots we visited, had a length of 150 m and a width of 40 - 60 m, a size that was said to be the standard for all other beachs-plots. Thus, the entire 7 km of beach is divided into a maximum of 45 plots of approximate equal size. Each plot is kept free of invading vegetation by its owner. Egg-collec-

Figure 47 Egg-collecting activities at the Galela beach (Nor theast Halmahera). [photo: C.J. Heij]

ting by others than the owner (and his family) is strictly forbidden.

We saw some birds fly in at dawn from the mountainous hinterland. They first stayed hidden in the mangrove and then proceeded digging burrows as soon as it got totally dark. In general the local egg-collectors do not visit the nesting grounds at night as they do not want to chase off the birds to a neighbouring plot. Egg-collecting therefore takes place during daylight hours, mostly in the early morning. We witnessed the collecting activities (two eggs were unearthed) and found out that the emptied burrows are not refilled: therefore the entire beach is covered with pits and heaps. The surface temperature of the black sand (measured 1 February 1995 at 15.00 p.m.) appeared to be 42ºC, a much higher value than the temperature of the surface soil at the Tanjung Maleo nesting ground on Haruku (see Table 14).

The following other information could be obtained through local contacts and personal observations: (1) eggs are sold at the local market for 600 rp each (Fig. 48); (2) adult birds are caught just before dawn (while still in the burrow) and consumed; (3) most eggs are laid during the full-moon period on cloudless nights; (4) the depth at which eggs are laid varies: during clear full-moon nights it exceeds 1 m, during dark nights it is 0.5 - 1 m; (5) it is assumed that a single bird lays one egg per week, during a period of six months; (6) the incubation-period is said to be seven weeks; (7) some, but not all, local collectors mentioned a decrease in the number of eggs.

The owner of the plot we visited, was able to present us a clear picture of his harvest results, which – according to local information – also applies to the other plots: during the so-called peak months of April to June between 20 and 40 eggs are collected each day, in the period July - September the number decreases to an average of 4 eggs each day , and in the rainy period October - March only 1-3 eggs are harvested each day, sometimes even none. Assuming that these data are trustworthy , a rough calculation of the total harvest per year for both a single

Figure 48 In Galela (Northeast Halmahera) the *Eulipoa* eggs are wrapped in woven palm leaves and subsequently sold. [photo: A.G. Heij-Ruuls]

Table 40 A calculation of the number of harvested *Eulipoa* eggs on the Galela nesting ground (NE-Halmahera), based on local information obtained in February 1995.

			total egg-harvest per year	
harvest period	number of days	eggs per day	per plot	entire area[1]
April- June	90	20-40[2]	2700	108000
July - September	90	4	360	14400
October- March	180	1-3[2]	360	14400
yearly totals	360		3420	136800

[1] the entire nesting ground is divided into 45 plots of equal size
[2] the median value was taken to calculate the total egg harvest.

plot and the entire nesting ground (Table 40) indicates the importance of the Galela nesting ground: an estimated 136800 eggs are collected each year, a figure that outnumbers the harvest of the Tanjung Maleo nesting ground on Haruku three to four times. The number of egg-laying birds amouts to 13000-14000. One could question if the entire stretch of 7 km beach is indeed divided into 45 plots which also all house about the same number of egg-laying birds. Interviews with local plot owners and our personal observations unequivocally resulted in the above mentioned information. Dekker et al. (1995), however, judged the size of the Galela nesting ground much smaller and their locally obtained information pointed at 500-1000 birds visiting the area each night during the peak season and up to 400 eggs being collected daily in March, April and May.

Recommendations - We feel that this area needs further study and recommend a long-term project to establish the size of the *Eulipoa* population at Galela and the impact of egg-collecting on the breeding success. The current management of the nesting ground by means of the 'plot-system' (instead of the 'sasi-lelang system' of Haruku) might play a key role in the survival of *Eulipoa* in the Galela area. Recently, Baker (1997) reported a two month study carried out in 1996 on a nesting beach in Halmahera. Although not specifically mentioned, the study area most likely was Galela.

The Meti island-group

This group of small offshore islands called Meti (Miti), Gumulamo, Magaliho, Kolorai and Rep are situated in Northeast- Halmahera, about 20 km south of Tobelo Town (Fig. 40). De Wiljes-Hissink (1953) mentioned the presence of a large *Eulipoa* nesting ground on the isle of Meti. Reports on the present status of this nesting area are lacking. To investigate this matter we visited Meti (Table 36) and some smaller satellite islands. The main island (4.5 x 2.0 km) appeared to be totally transformed into an agricultural area, offering a living for 1500 inhabitants. The coast is mainly rocky and holds some mangroves. The few sandy beaches get flooded at high tide and the higher sandy grounds bordering the beach are heavily vegetated. We could easily establish that *Eulipoa wallacei* does not occur any more on Meti. Not a trace could be found and both bird and egg were locally unknown. In many cases one presented us eggs and specimens of *Megapodius freycinet* which appeared to be reasonably common and to be consumed regulary. Only one elderly local could recall the nesting of *Eulipoa* on the southern point of the island, but that was 'long time ago' he said. Our survey of the island had indeed established the beach of the southern point to be suitable, but – as elsewhere on the island – not a trace of the bird could be found. The same goes for the smaller islands near Meti.

With De Wiljes Hissink (1953) in mind, human population growth and accompanying activities have, in a period of some decades, achieved the total abandonment of a large nesting ground.

Offshore islands near Tobelo

While visiting the town of Tobelo in Northeast Halmahera, we noticed a number of small offshore islands, called Popilo, Gorua, Tolonuo, Barabgane, Karara, Tagalaya, Pawale, Kakara, Tupu Tupu, Kumu, Bobi, Koyobata and Tuku. As we suspected the presence of *Eulipoa* nesting grounds, the coast of each islet was surveyed from a dugout canoe. It soon became clear that most of the islands are uninhabited, consist of mangrove forest and have a rocky coast. Others have sandy beaches, and are grown with coconut palms and house a small human population. Local fishermen were present on all islands. Much firewood is being cut and bunches of firewood lie on the beach ready to be picked up. We only visited islands with a sandy beach. Both from personal observations and interviews with locals we established that *Eulipoa wallacei* does not occur on the Tobelo island-group. No reports of past occurrence were given either.

A conversation with two elderly inhabitants of Tobelo yielded an interesting story about an attempt to introduce *Eulipoa* in the 1930's near Puao in the Wasile Bay area and on Tanjung Baru near Wosia (Tobelo District, Halmahera). One reburied eggs (probably from Galela) at the coastal sites, hoping that this would produce a new nesting-population of which the eggs could be collected for consumption. We were told that at the time, the village chief had declared the Wosia beach a no-go area in order not to disturb the birds. However, an egg-laying population was never established as the area was still being disturbed by cats, dogs and agricultural activities. At the end of the Japanese occupation the inhabitants of Tanjung Baru were winning sea-salt. This activity definitely disturbed the efforts to introduce the birds.

MOROTAI ISLAND

Morotai, the northernmost Moluccan Island (Fig. 40), measures 400 km^2, is thinly populated and still has a substantial inland forest area. Contrary to Halmahera, its beaches consist of pure white sand. We searched the entire south-western coastline on 5 Februari 1995 (Table 36), but despite the excellent condition of the beaches and the bordering higher sandy grounds, did not find any trace of the bird. Local people were totally unfamiliar with *Eulipoa* and, time after time, directed us towards the mounds of *Megapodius freycinet*. So we could not confirm the 'possible occurrence' of *Eulipoa* on this island, as indicated by Jones et al. (1995) [Table 35]. The forested mountainous inland area, still could form an excellent habitat.

BACAN - KASIRUTA ISLAND

The islands of Bacan and Kasiruta, situated west of South Halmahera (Fig. 40) are inter-connected by a chain of small islands. The Bacan group consists of the islands Nusara, Ambali, Obit, Mandioli, Kamalayu and Mandyau. The Kasiruta group comprises Tarakeang, Nusa Uwa, Imbatin, Nenas, Jalintang, Batu Mampat, Tawabi, Nanoang, Tudu and Toduku. Many islands are small and consist mainly of mangrove vegetation on the sea-side and coconut palms in the humid inland area. Other islands protrude from the sea as overgrown rocks. Islands with sandy beaches are few in number. We visited all islands, including the two main ones, which had sandy beaches, by dugout canoe. Despite serious efforts (Table 36) we did not find any indication of the presence of *Eulipoa*. Both inhabitants of coastal villages and fishermen did not know the bird either. Again, like on Morotai, *Megapodius freycinet* was well-known and we found the birds and their mounds to be common on all islands. To our surprise we even found mounds of *M. freycinet* on beaches (which do not flood) and observed the birds foraging on the beach as well.

The absence of nesting grounds on Bacan and Kasiruta is surprising as the hinterland of the main islands, consisting of rather high, densely overgrown mountains, is a well-known inland *Eulipoa*-habitat. From Mount Sibela on Bacan some adult specimens have been collected (Heinrich 1956; Ripley 1960), and from a more recent date there is even a sighting of a bird (Lambert 1994). Therefore we do suspect some irregular nesting on the coast, but could not find

Table 41 Summary of the status and stability of all known nesting grounds of *Eulipoa wallacei* on the Moluccan Islands and the Western Papuan Island of Misool, based on a survey in the periods September 1994 - April 1995, April 1996 and April 1997. For Buru see also Tables 38 and 39.

island	nesting ground	status*	stability**
Haruku	Tanjung Maleo (Kailolo Village)	1	A/B
	Haruku Village	3/4	B
Pombo	Pombo	4/6	B/C
Ambon	Liang, Hunimuna	4	B/C
	Tawiri	6	--
Saparua	--	7	--
Nusa Laut	--	7	--
South Seram	Kairatu - Latu	4	B
	Iha (Wa Oewe - Wa Tala)	3	C
	Tanjung Koako (Amahai airstrip)	3	B
Southeast Seram	Geser Island, Dawan, Bitorik, Kirukut	3	D
North Seram	Wahai-East (Labuan - Tanjung Sariputih)	1/2	A/B
	Wahai-West (Wahai - Saleman/Saka)	7	--
	Wahai-West (Saleman Bay, Roho)	2/3	D
	Wahai-West (offshore islands)	3	A
West Seram	Boano, Babi, Kelang Islands	4	A
Southwest Seram	Babi Island	4	A
	Kasa Island	2/3	A/B
North Buru	Wa Kose (WWI), Wa Pait, Wamlana, Wa Pure	2	A/B
	Lamalang, Wa Plau; Air Buya, Wa Kasi Utara	3/4	B
	Lala - Wa Peran; Sama Lagi Laut - Wa Putih	6	--
South Buru	Wa Kuma, Wa Wawal, Wa Kasi; Oki Baru, Oki Lama, Tanjung Pohonbatu	2	A/B
	Wa Bobo, Wa Turen, Wa Haka; Wa Mala, Ewiri; Wa Tina	3	B/C
	Namrole, Wa Naka, Kaya Putih, Wa Teba	3/4	C

Table 41 continued

island	nesting ground	status	stability
Ternate-Tidore	--	6	--
Halmahera	Gamkonora	2/3	B
	Galela	1	A/B
	Meti Island	6	--
	Islands off Tobelo	7	--
Morotai	--	7	--
Bacan-Kasiruta	--	7	--
Obi	--	5	D
Misool	--	7	--

Explanation of codes for status and stability

* Status (importance)
1 major nesting ground(s), regular nesting by large numbers
2 nesting ground(s) of moderate importance, regular nesting by substantial numbers
3 minor nesting ground(s), regular nesting by small numbers
4 marginal nesting ground(s), irregular nesting by small numbers
5 nesting ground(s) present according to local information, no proof
6 abandoned, no present nesting
7 no nesting ground(s)

** Stability
A stable (viable)
B declining
C declining rapidly
D unknown

Large numbers
> 100 eggs per night during peak season
approximate total egg-laying population > 2500 females

Substantial numbers
20 - 100 eggs per night during peak season
approximate total egg-laying population 1000 - 2500 females

Small numbers
< 20 eggs per night during peak season
approximate total egg-laying population < 1000 females

proof. Most birds, depending on the size of the population, will probably fly to the southwest coast of Halmahera for nesting. However, from that region no reports of nesting ground are hitherto known.

OBI ISLAND

The Obi island-group, situated south of Halmahera (Fig. 40) comprises a main island (Obi) and some smaller satellite islands. In the northwest there are the isles of Bisa, Tapat, Belang Belang, Obilato, Maca Maca and Mala Mala; in the southwest Gumunu and in the east Tobolo. The Obi group is not yet known to hold *Eulipoa* nesting grounds or inland habitat where the bird occurs. Jones et al. (1995) list Obi as an area of possible occurrence (Table 35). We surveyed the area on two occasions (Table 36) and could not find proof of the occurrence of *Eulipoa wallacei*.

The coast of Obi mainly consists of mangroves. The few beaches are being occupied by human settlements. We found *Megapodius freycinet* everywhere on the coast of both the main island and the smaller ones. Local inhabitants are also familiar with his bird (known as 'maleu') and we also got many reports of the presence of 'mamua', the local name of *Eulipoa wallacei*. According to local fishermen, the bird has nesting grounds on the beaches of Belang Belang and Mala Mala. When we visited both islands (in April 1995), unfortunately at that time the small beaches did not bear any trace of nesting by *Eulipoa*. Occurrence in the inland area was not investigated by us. Linsley (1995) did not encounter the bird.

THE WESTERN PAPUAN ISLANDS

The only island outside the Moluccan province know to be inhabited by *Eulipoa wallacei* is Misool. Biogeographically this island belongs to the Papuan region (Mees 1965) whereas the Moluccan Islands are part of the area generally called 'Wallacea' (White & Bruce 1986). The presence of *Eulipoa* on Misool was discovered in 1954 by Ripley (1960): he collected some specimens in the inland area near Tamulol (Table 35). Since its discovery, no further records of the species and/or its nesting grounds have become known from the island (cf. Jones et al. 1995).

MISOOL ISLAND

Misool was visited during the period 4-9 April 1997 (Table 36). The entire coastline and its offshore islands were searched for suitable nesting beaches by boat, and when necessary on foot. On the few suitable sandy beaches that appeared to be present, no traces of the bird was found. Although *Megapodius freycinet* and *Aepypodius arfakianus* (and their nesting habits) appeared to be well known by local villagers, the Moluccan megapode and its nightly egg-laying behaviour was unknown. The local name 'holeiko' (see: Ripley 1960) applied to *Megapodius* and *Aepypodius*. Once the name 'sagoil' (meaning 'scardy-cat') was mentioned. This name could possibly refer to the secretive behaviour of *Eulipoa* in its inland habitat. The inland area of Tamulol was also visited, but the bird was not found and was not known by the villagers either. The present occurrence of *Eulipoa* on Misool could therefore not be established by our survey (Heij in prep.[b]).

CONCLUSIONS OF THIS CHAPTER

Our extensive survey of the Moluccan Islands has established that the world population of *Eulipoa wallacei* has two main strongholds: Tanjung Maleo (Haruku) in the south and Galela (Halmahera) in the north (see also Dekker et al. 1995). Galela probably hosts the largest number of egg-laying birds, but is a relatively large area (280000 m^2 used for nesting). Of all encountered nesting grounds, Tanjung Maleo (Haruku), however, gets most eggs (and birds) on an extremely small surface (125000 m^2 of which only 5450 m^2 is used for nesting). In addition to these two major nesting grounds, the Wahai-area (North Seram), the river mouths of Wa Kasi and Tanjung Pohonbatu (South Buru), Wa Kose (North Buru), and to a slightly lesser extent, Gamkonora (West Halmahera) and Kasa Island (Southwest Seram) still have nesting grounds where substantial numbers of eggs are being laid. Especially on the beaches east of Wahai the number of eggs approaches the numbers found in Tanjung Maleo and this area could be ranked as the third stronghold. Hitherto these medium sized nesting grounds were either unknown, or their status had not been reassessed since their intitial discovery. One former major nesting ground (Meti off Halmahera) appeared to have been totally abandoned since a few decades. Minor nesting grounds, where small numbers of eggs are laid either regulary or irregulary, are present on most Moluccan islands within the species' range. Table 41 summarises the status and stability of all known nesting grounds.

Although almost no comparative data exist, local information clearly and unequivocally points toward declining numbers of birds and eggs in most areas. Dramatic losses of numbers and of the nesting grounds themselves appear to have taken place during the last few decades. Presently, most medium sized and all major nesting grounds suffer from heavy exploitation of eggs and in most areas adult birds are caught for consumption. In addition, hard-set eggs and newly fledged chicks are handled indifferently, causing an extra decline in breeding success. However, it does seem that exploitation at the two major nesting grounds is sustainable, as still (after at least a century of egg harvesting) large numbers of birds visit the areas for nesting. Minor nesting grounds located in areas with a low human population density are less affected by egg collecting and house relatively stable but small *Eulipoa* populations. Local customs ('adat') like 'sasi', which give nesting grounds a protected status, proved to be crucial at Tanjung Maleo, but loses influence on most Moluccan islands. Only Tanjung Maleo on Haruku is known for its 'sasi-lelang' system, in which a community sells the harvest rights to the highest bidder. In this respect, the effect of the 'plot system' of Galela (Northeast Halmahera), in which parts of the beach are privately owned, needs further study. In addition to that, we strongly advocate research programmes that monitor the medium sized nesting grounds. Only then the full impact of the exploitation of eggs and massive loss of both the coastal and the inland habitat will be fully understood.

'Everyone wants them', Abatan said. One day I said 'Do you have the number of megapode birds as years ago?' 'No, we have less'. It was predictable enough. 'So why don't you give the eggs a chance to hatch? That way you'd end up with more birds and more eggs'. 'The young people would never accept it, although that was done in the older times, when the bird was worshipped with sacrifices'. That day he showed me the grave of the man who was the last person to carry out sacrifices. The man, Kigata, had died in 1965. The usual sacrifice was the burning of a pig to ashes in a tabu-grove on the cliff behind the village.

from: Paul Theroux, The happy isles of Oceania, 1992

12 CONSERVATION

In general, *Eulipoa wallacei* is considered threatened. Collar et al. (1994) list the species as 'vulnerable', meaning a 10% chance of going extinct within 100 years. They predict a likely rapid decline in the near future (of more than 50% of the population over 20 years) based on a decline in the area of occupancy, the extent of occurrence and / or quality of habitat, and the actual or potential levels of exploitation of the species (IUCN-criteria A2b,c). The population is listed as 'small and declining continuously' numbering less than 10.000 mature individuals (IUCN-criteria C1). This judgement, although based on limited data, is probably right, but we expect the total population to be somewhat larger. Also in our view, *Eulipoa* is vulnerable for extinction. Our surveys in the Moluccas (see chapter 11) indicated that the species has only a few strongholds and, according to local information, numbers of birds and eggs have declined seriously during the past decades. In this chapter we highlight the causes of decline and present conservation strategies with emphasis on the nesting grounds of Haruku Island.

Legal protection

In Indonesia, *Eulipoa wallacei* is a legally protected species. The law prohibits (1) to catch, injure, kill, keep, possess, care for, transport and trade the protected animal in live condition, and (2) take, destroy, exterminate, trade, keep or possess an egg and/or a nest of the protected animal. In spite of this legal protection, both eggs and adult birds are collected, sold and consumed on a large scale throughout the species' range. Local people are not aware of the protected status of the bird, and if they would know, they would not care. The authorities are aware of this situation, but take no action. In case of the Tanjung Maleo nesting grounds, any forcibly implemented measures to stop the egg collecting, which is deeply rooted in the village community (see chapter 3), would create resentment, and in our opinion, would achieve the opposite: uncontrolled collecting by all villagers and destruction of the surrounding forest. Involvement of the local people in any conservation programme is therefore crucial.

Causes of decline

Although the data on the numbers of collected eggs at Tanjung Maleo show an increase during the past decade (see: chapter 9, Fig. 33), the local egg collectors and elderly villagers report that 'in the past' many more egg-laying birds visited the area. Then, during the dry season, with little effort, daily numbers of collected eggs regulary reached 300 or more, while nowadays numbers exceeding 200 are seldomly collected (Table 30), the effort, however, being much greater. Factors that are most likely responsible for the decrease are:

1 Human population growth and hence the extension of the village and space used for agriculture. Also the cemetery is extended into the sandy fields used for egg-laying. More sand is needed for the building of houses.

2 Road improvements, meaning more traffic, also during the night. Formerly the road along the nesting ground was closed during the night. Now, nightly traffic causes disturbance and death (birds sometimes collide with motorbikes).

3 Increasing mobility as a result of the increasing prosperity: more motorbikes, cars and speedboats and the accompanying extension of the landing pier from where speedboats transport people to other islands. Selling eggs elsewhere on Haruku and on other islands is now possible. New markets for eggs are open and create a higher demand, which results in more intensive collecting.

4 Installation of electricity. Formerly oil-lamps were turned down at night, but presently the lights in houses are left on all night, possibly disturbing in-flying and returning birds. Moreover, birds often fly against the electricity wires and are killed.

5 Disturbance by students and birdwatchers. Students, who want to gather information the easy way, illegally stagger across the nesting grounds. Nightly excursions for birdwatching-tourists, conducted during the past 15 years, have a very disturbing effect on the egg-laying birds.

6 The harvest system employed at Tanjung Maleo is completely aimed at material interests and has no eye for the reproduction of the bird. The lease price for the harvest rights has almost doubled during the recent years (see Table 4) and, likewise, egg-harvest activities are increasing: as many eggs as possible are collected. Methods such as frightening the females ready to lay their eggs, so that the birds get anxious and lay less deeply, eases the harvest but seriously disturbs the behaviour of the birds. Prolonged and intensive searching for eggs, during both day and night, causes damage to eggs that had not been found earlier, as well as to hatchlings on their way to the surface. Morever, the discarding of hard-set eggs (which have no commercial value), dramatically reduces the hatching chances of eggs that escaped from human hands just after being laid. As noted earlier (see also Heij 1995a), the assumption that the harvest system at Tanjung Maleo purposely leaves about 20% of the eggs untouched in order to keep the population in balance (Dekker 1991, see also Del Hoyo et al. 1994 and Monk et al. 1997), proved to be wrong. Instead, about 10-15% (13.7 % in 1994/1995) is simply not found by the collectors and has a chance to hatch.

Positive aspects of the 'sasi-lelang' system

Apart from the disturbing effects and the high pressure on the *Eulipoa* population, the harvest system at Tanjung Maleo also has a few aspects that are advantageous for the bird. The lease-holder and his team protect and maintain the nesting grounds. They prevent the surrounding forest from being cut down and make sure that there is no hunting. Invading vegetation at the sandy fields is removed. As did Göth & Vogel (1995) for *Megapodius pritchardii*, we noticed elsewhere in the Moluccas that over grown nesting grounds are no longer used for laying by *Eulipoa*. Keeping the nesting ground devoid of any vegetation or plant debris is therefore essential. As far as possible, the tranquility is maintained. New resting places for the birds are created by planting young trees and during the Islamic fasting the cemetery is weeded, creating more sites for nesting amongst the graves. Predators, especially dogs, snakes and monitor lizards are exterminated (see chapters 3 & 10). The bird itself is also protected by local custom ('adat'): adults and chicks are not collected.

Survival: importance of local custom

We believe that the maintenance of the sandy fields and the protection of the surrounding forest has been essential to the survival of Tanjung Maleo as a major *Eulipoa* nesting ground. So far, the community of Kailolo has managed the area in such a way that it is, in our opinion, one of the best preserved natural areas in the Moluccas, where, despite the ongoing and increasing egg harvest, still vast numbers of Moluccan megapodes frequently lay their eggs. Apparently *Eulipoa* can still cope with the extremely high egg predation (exploitation), probably because – once adult – they reach a relatively high age and thus need few offspring to maintain a stable population size. Otherwise, Tanjung Maleo would have been devoid of any megapode long time ago. In this respect the 'sasi-lelang' system protects the nesting ground and indirectly ensures the survival of the species. As long as local custom ('adat') exercises its influence, the Tanjung Maleo nesting ground will remain in reasonable condition, but we have witnessed that even in the traditional community of Kailolo the 'adat' loses ground. Therefore, it is essential for both the protection of the nesting ground and the bird that educational programmes for the younger and new generations are established. Just giving Tanjung Maleo the status of nature reserve and prohibiting the egg-harvest will certainly not have any positive effect. Other conservation strategies that we recommed, are measures that directly involve maintenance and management of the area, and a re-introduction programme.

Education

Along with the economic development of the Moluccan islands, the natural habitat is disappearing and human traditions on Haruku Island are being abandoned. In the near future Allah and 'adat' will no longer ensure the ongoing availability of eggs, but the the people themselves will be responsible. In order to retain *Eulipoa* as a breeding bird and even to increase its numbers, the inhabitants of Kailolo will have to learn to live with these changes and establish active protection of the nesting ground and the surrounding forest. In this way they are assured of an income as well as a protein food-source. With this in mind, educational programmes need to be created. Basic to this should be the (1) continuation of egg-collecting by a single family that leases the nesting ground for a year, and (2) creating awareness that the people themselves are responsible for the availability of eggs.

During this study the inhabitants of Kailolo were very willing to learn and to cooperate, and therefore we believe that an educational programme can be successful. The University and Teacher Training College of Ambon and the Bogor Agricultural Institute (IPB) have offered their assistance. Students can teach the villagers about their place in nature within a changing society and about their crucial position within the ecosystem of Tanjung Maleo. They should highlight the negative points of the egg exploitation system (over-harvesting, disturbance, not returning hard-set eggs to the burrow, killing emerging chicks), but also stress the positive side (protection of the area, preventing predation). New rules governing the egg collecting and maintenance of the area should be implemented. Local TV can play an important role in achieving this.

Teaching local schoolchildren is crucial and should include slide-shows about the biology of the megapode, educational posters and excursions to the nesting grounds. Besides, schoolchildren should be involved in the maintenance of the nesting grounds by executing light duties such as planting trees and keeping the sandy fields clean and free of invading vegetation.

Excursions for birdwatching tourists, which so far have a very disturbing effect, should be managed by local people. To prevent disturbance an observation hide is necessary. This hide can also serve as a small-scale visitors centre (slide-shows and sales of postcards etc. during daylight hours). If managed properly, this hide can generate additional income. In the end, the local villagers will have to be able to execute these programmes independently.

Maintenance and management of the nesting ground

To reduce and regulate the egg-collecting activities at Tanjung Maleo, we recommend the following possible measures:

1 Prevent disturbance of the egg-laying birds as much as possible: no trespassing, chasing-off and collecting during hours of darkness; close the road along Tanjung Maleo during the night.

2 Unearthed hard-set eggs should be reburied immediately at safe (but sunny) places along the edges of the sandy fields.

3 Implementation of a non-harvest period each year, preferably during the rainy season when the number of eggs is lowest, and the motivation to harvest is low as well.

4 No collecting on one of the four sandy fields, and alternate this every year. This suggestion was made back in 1988 by the then Minister of the Environment Prof. Emil Salim. Argeloo & Dekker (1996) suggested to declare 10% of the nesting ground an 'egg-collecting-free zone', in combination with a 10% increase of the egg-price.

5 Increase the surface suitable for egg-laying by creating sandy spots at the cemetery. This means weeding sould be done frequently (not only during the muslim fasting).

6 Increase and improve the forest that surrounds the sandy fields. Especially on the eastern side of Tanjung Maleo, where the sandy fields are bordered by the cemetery, planting of trees is necessary. A narrow stretch of forest can serve both as a buffer for noise and headlights of vehicles and as a hide-away for arriving adults and fledged chicks.

7 Relieve the lease holder from the economic necessity to collect as many eggs as possible. This can be achieved by supplying funds to buy the harvest rights (see also Argeloo & Dekker 1996). In a situation like that, every egg that is sold, yields a profit as the lease holder has no debt. So he can take it easy. In return, an agreement with the lease holder should include the following: (1) only half of the the usual number of eggs is allowed to be collected (deeply buried eggs will not be unearthed and there will not be any collecting on the cemetery);(2) villagers of Kailolo should be given first choise in buying the eggs (no export to other islands); (3) during the Islamic feasts the poorest villagers will receive eggs for free. Agreement 1 gives the bird a better chance of survival and agreements 2 and 3 ensure the adat (communal ownership of the nesting ground) is adhered to. Heij has raised funds to execute this plan in the near future[8].

Re-introduction

This study established that reburying freshly laid or hard-set eggs, given the abiotical factors remain more or less the same, has no technical problems and gives a high hatching rate (see chapter 6). As megapode chicks do not need any parental care (artificially bred maleo chicks *Macrocephalon maleo* could be released immediately after hatching, Dekker 1990), this indicates good prospects for relocating and reburying eggs as a conservation measure. Eventually this could lead to (re)introduction of *Eulipoa* in places were it is presently lacking or disappearing. It is, however, essential that an adult bird returns for egg-laying to the nesting ground where she had hatched. Indeed, recent efforts (1991-1993) to introduce the burrow-nesting Polynesian megapode *Megapodius pritchardii* on the Tongan islands of Fonualei and Late by relocating eggs, were successful (Rinke 1994, 1995). Also in 1996 adults and chicks were seen at both sites (Claudia Matavalea pers.comm. 1997).

The island of Haruku has two potential nesting grounds for a reintroduction programme. The most important site is Haruku Village, the minor one is the small offshore island of Pombo (see chapter 11). On both sites small numbers of eggs are laid irregulary (Table 41). At Haruku Village a local inhabitant has already planted trees on the high grounds of the beach to improve the suitability and we discussed a plan-of-action with the village chief. Like in Kailolo, an educational programme should prepare the local people for the coming changes (now everybody collects and there is no 'sasi', see chapter 11) and the tenant(s) have to be trained to handle/ rebury eggs and to maintain the nesting grounds[9]. Know-how from Kailolo is available and their practices (hopefully to be adapted according to our plan) can serve as an example.

Loss of habitat

In addition to the exploitation of eggs, the loss of inland habitat also threatens the Moluccan megapode. Especially in Halmahera, Buru and Seram we have witnessed extensive logging of the forest. We expect this degradation of the vegetation to be unfavourable, although this study has shown that *Eulipoa* resides in degraded secondary forest and even in neglected cultivation areas (see chapter 8). Whether this phenomenon is an actual adaptation to the loss of primary inland habitat, or whether *Eulipoa* has always occurred in a wider range of habitats, it does anyhow increase the species' chances to survive the ongoing destruction of nature in the Moluccas.

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[8] Recent reports from Kailolo (Heij, pers. obs. March/April 1997), however, established that a 'foreigner' (a military officer living on Java) obtained (bought!) the harvest rights for two years through direct negociation with the village-authorities (no auction was held). We expect increasing egg-collecting activities.

[9] From January 1997 onwards the nesting ground near Haruku Village does not suffer from egg-collecting activities. On 21 April the first batch of 24 *Eulipoa* eggs was transferred from Tanjung Maleo to desa Haruku and were reburied at the protected ('sasi') nesting ground (Heij in prep.[a]). See also chapter 11.

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APPENDIX 1 Basic data on egg number s

harvest year 1987/1988 (total egg-ha rvest 18260)

A	91	84	91	115	97	115	116	87	85	89	83	74	96	80	102	94	99	90	105	95	78	100	78	75	61	61	57	59	72	68		2597
M	27	35	57	65	49	50	55	58	58	58	57	56	50	45	58	52	55	67	65	65	65	65	44	49	46	30	35	22	31	26	28	1523
J	35	29	15	32	35	22	28	31	19	18	19	18	21	23	18	16	25	24	26	28	18	16	12	11	8	10	7	8	9	8		589
J	8	10	9	9	12	10	10	10	10	7	7	7	10	11	11	12	13	11	11	12	13	7	8	6	6	5	6	6	5	5	0	267
A	5	5	6	6	5	5	7	5	10	6	9	12	8	11	11	17	21	17	22	8	11	21	10	7	15	8	8	9	10	13	10	318
S	8	14	14	21	19	35	35	29	27	32	45	45	39	37	42	20	27	16	37	38	23	16	18	18	22	30	12	25	19	28		791
O	24	32	32	34	32	31	35	51	47	59	42	50	54	27	108	40	70	34	54	50	34	27	36	31	37	38	50	43	48	47	59	1356
N	45	37	45	53	62	57	52	87	80	91	75	101	63	69	65	61	47	60	28	66	39	49	51	45	61	35	82	75	44	64		1789
D	55	53	56	32	52	74	67	65	56	76	82	90	76	77	77	83	50	82	57	50	75	54	45	60	84	88	61	87	65	56	55	2040
J	55	68	57	80	77	67	84	85	89	91	69	70	73	60	66	78	75	72	70	49	96	79	74	56	76	66	70	73	70	65	67	2227
F	82	117	89	95	98	85	88	77	68	21	83	99	76	61	76	78	114	82	74	99	77	111	71	78	67	77	69	68				2280
M	111	65	65	111	95	117	108	86	67	89	84	77	35	121	40	138	75	89	72	76	83	68	60	55	87	62	68	65	62	71	81	2483
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**		

harvest year 1988/1989 (total egg-ha rvest 27978)

A	145	145	147	127	127	131	75	152	125	111	118	115	119	89	100	87	134	99	113	89	108	113	116	105	105	79	65	85	101	118		3343
M	98	93	99	115	106	86	94	105	100	77	85	86	77	87	73	57	56	58	57	49	55	69	61	67	41	41	32	42	52	53	67	2238
J	42	44	40	52	47	50	52	38	45	17	54	26	36	32	26	24	27	27	32	35	31	19	9	29	13	30	18	24	19	17		955
J	22	17	21	29	19	9	16	0	26	10	11	5	10	15	6	7	12	6	11	5	14	9	8	8	14	15	13	11	23	18	19	409
A	29	17	21	35	38	25	33	15	15	8	11	15	22	21	12	16	17	13	9	20	13	21	26	29	32	39	31	63	69	65	68	848
S	67	55	77	58	32	61	30	30	46	37	19	25	26	27	25	45	55	75	78	25	122	84	141	123	110	93	77	75	79	65		1862
O	76	102	69	73	101	110	108	93	90	86	65	79	96	90	92	109	60	115	105	65	105	99	129	90	122	108	112	128	114	105	125	3021
N	95	104	126	90	140	122	114	113	108	29	66	101	93	94	125	97	103	133	114	118	95	93	88	62	108	101	93	99	96	106		3026
D	120	107	90	72	78	88	99	106	75	69	90	129	87	111	121	82	110	108	108	107	123	75	115	75	90	109	145	121	154	115	145	3224
J	149	94	85	102	78	106	109	148	156	120	105	100	95	105	92	100	106	107	109	107	131	134	120	90	118	94	121	82	117	105	105	3390
F	84	90	118	86	105	86	105	100	78	77	98	85	82	126	134	128	146	135	99	85	111	111	105	105	118	115	125	109				2946
M	113	106	108	98	35	123	93	23	109	26	76	93	112	82	92	78	75	82	76	81	81	47	73	111	114	119	128	100	121	67	74	2716
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**		

APPENDIX I (continued)

harvest year 1989/1990 (total egg-harvest 22934)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
A	89	98	99	71	68	86	105	115	100	117	101	108	108	98	20	141	105	94	103	100	88	72	111	99	93	104	87	81	103	98		2862
M	70	95	90	88	80	62	78	74	55	60	50	56	75	63	51	66	66	76	60	60	68	50	52	45	44	51	52	51	39	38	39	1904
J	30	44	17	29	38	37	30	34	45	42	36	43	31	26	39	21	26	22	30	20	13	32	25	39	24	19	16	42	20	11		881
J	22	19	13	17	14	15	14	17	19	15	12	9	15	12	11	12	11	11	11	9	13	14	13	13	13	14	13	18	11	10	16	426
A	12	7	8	7	12	9	16	9	10	12	8	9	11	14	16	13	16	17	18	16	23	24	29	25	39	27	47	26	30	22	11	543
S	14	13	10	14	19	14	19	25	23	41	55	31	52	50	47	51	59	65	67	47	58	70	47	61	94	51	76	35	22	52		1282
O	45	35	36	45	50	49	54	57	56	70	86	97	69	105	88	94	86	52	50	62	76	86	68	98	79	87	85	82	85	106	89	2227
N	105	77	84	90	73	90	74	88	97	76	87	90	78	100	105	79	93	79	87	80	91	71	94	67	69	86	71	75	85	75		2516
D	48	76	78	81	102	77	110	70	78	80	77	89	70	88	69	67	81	100	96	86	70	85	76	100	68	64	78	80	79	86	63	2472
J	93	81	97	100	81	68	59	77	75	78	70	63	78	86	106	120	134	100	84	117	91	80	75	75	53	73	80	72	75	103	100	2644
F	78	71	68	75	81	70	82	95	110	100	76	110	107	119	110	87	103	94	105	75	92	110	76	76	102	78	84	81				2515
M	72	89	113	92	53	107	95	75	74	92	82	102	85	76	95	72	95	73	84	82	98	93	85	96	78	80	89	92	80	83	80	2662

harvest year 1991/1992 (total egg-harvest 27648)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
A	113	118	113	125	95	113	110	125	122	130	110	110	100	117	130	94	117	115	98	96	100	71	87	104	66	100	88	0	60	92		3019
M	85	80	85	93	72	74	80	98	70	80	83	80	62	73	72	80	74	70	58	76	71	70	56	60	53	53	45	53	25	20	40	2091
J	48	54	40	42	42	40	54	54	42	55	50	26	25	24	48	25	27	28	22	16	25	21	11	24	15	10	14	7	13	18		920
J	15	8	8	4	12	15	15	9	11	15	16	11	12	16	13	8	12	13	5	15	4	6	6	1	8	3	4	7	16	4	5	297
A	0	6	10	5	19	23	22	20	28	40	45	41	28	45	0	42	7	7	11	20	7	12	8	7	8	5	5	8	10	15	8	512
S	18	40	49	87	86	91	85	93	93	90	90	74	81	65	56	60	53	63	52	60	58	50	40	45	50	70	50	60	78	70		1957
O	91	122	135	158	152	175	130	148	139	170	156	172	15	147	100	80	98	82	85	88	90	105	77	100	102	110	137	140	170	170	168	3812
N	143	193	160	152	144	155	151	111	174	156	180	153	165	151	150	156	150	149	115	140	120	115	120	115	110	115	110	110	105	108		4176
D	103	91	105	65	88	100	90	100	100	100	90	102	80	72	70	80	85	84	66	80	75	100	99	101	140	116	130	123	132	130	118	3015
J	119	118	99	105	110	109	97	111	114	110	95	66	60	62	66	45	60	60	63	50	70	60	95	81	70	70	94	60	70	57	0	2446
F	70	100	146	120	117	105	122	100	50	81	122	110	112	80	51	50	62	110	111	70	118	82	117	115	115	114	109	98				2757
M	80	82	88	75	109	106	80	90	68	100	94	80	109	85	95	60	65	66	70	74	100	95	90	91	93	101	76	61	65	105	93	2646

APPENDIX 1 (continued)

harvest year 1992/1993 (total egg-ha rvest 26886)

A	113	117	72	79	133	140	93	116	110	122	89	80	81	92	89	116	66	117	113	136	133	145	125	96	117	81	66	75	61	58		3031
M	62	95	65	85	78	75	87	44	128	83	110	73	68	77	85	58	76	75	76	78	79	87	77	85	60	73	55	31	75	32	71	2303
J	49	44	50	55	65	60	39	75	57	48	52	34	52	45	50	53	41	51	43	47	42	32	33	22	46	18	26	38	35	25		1327
J	25	27	19	13	21	21	25	24	27	19	31	23	23	25	28	27	23	19	7	22	34	27	33	10	20	21	15	26	16	13	8	672
A	11	7	10	10	20	11	14	19	16	30	37	35	31	37	41	35	42	51	33	33	31	32	31	27	27	29	27	33	40	32	31	863
S	41	31	31	42	36	55	33	39	49	44	63	99	69	100	78	85	89	79	66	67	65	54	61	65	76	66	45	60	45	52		1785
O	50	50	46	45	49	55	62	85	78	85	60	85	110	145	110	116	146	140	87	114	117	133	112	75	85	75	68	75	66	65	63	2652
N	78	82	55	53	70	75	55	65	79	88	89	99	73	87	78	75	85	48	67	47	65	65	61	45	42	47	47	49	41	50		1960
D	47	55	58	56	57	77	112	95	48	85	99	120	118	132	110	83	95	91	72	120	110	89	101	97	71	110	101	85	91	122	89	2796
J	110	98	110	120	113	130	101	100	112	115	114	118	121	95	97	95	90	111	100	85	87	110	99	116	75	150	95	98	123	103	72	3263
F	113	110	98	95	95	119	113	113	120	114	122	124	126	118	95	116	118	95	69	97	101	126	120	101	110	120	132	130				3110
M	111	114	122	120	123	99	95	90	102	122	85	101	95	140	122	95	116	95	99	75	87	69	57	79	136	95	87	95	110	101	87	3124

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

harvest year 1993/1994 (total egg-ha rvest 32722)

A	102	35	111	122	105	109	131	137	131	129	132	149	125	131	122	136	123	136	119	106	106	116	102	100	85	151	114	116	131	124		3536
M	137	111	115	119	115	87	93	125	65	135	104	128	128	103	104	87	104	86	73	53	30	71	34	61	45	61	38	56	42	71	59	2640
J	67	55	45	45	51	47	50	41	38	57	54	45	47	40	46	51	36	21	36	25	35	18	27	23	16	17	18	24	25	26		1126
J	25	26	44	31	31	25	29	36	44	18	31	22	26	35	37	26	15	12	26	17	18	21	21	18	23	18	15	26	22	14	48	800
A	30	31	35	45	55	51	60	51	61	61	41	29	31	31	32	26	26	23	31	0	31	33	34	28	31	31	35	41	44	44	57	1159
S	63	61	80	48	101	68	69	106	63	64	44	31	32	31	34	56	36	38	51	51	54	51	59	68	79	85	96	75	130	100		1924
O	93	113	78	116	114	102	95	84	68	118	91	67	38	98	51	54	60	69	45	36	65	54	54	75	106	106	106	91	131	96	137	2611
N	107	121	111	101	64	82	66	83	73	76	63	68	71	64	109	81	117	104	112	119	97	138	143	131	141	117	111	139	127	127		3063
D	141	165	135	151	155	147	120	131	123	124	125	131	78	141	162	133	126	135	139	114	120	139	122	131	108	134	111	144	172	159	161	4177
J	136	151	113	126	128	114	141	130	112	121	71	153	141	98	111	125	143	141	103	144	141	115	117	111	140	123	176	164	115	156	154	4014
F	151	137	165	127	121	127	114	129	132	123	131	139	111	149	141	161	169	201	126	135	157	121	167	171	147	141	129	161				3983
M	174	133	141	134	122	141	131	116	111	94	74	91	81	101	105	103	124	115	118	121	124	123	115	122	112	117	111	111	111	139	174	3689

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

APPENDIX I (continued)

harvest year 1994/1995 (total egg-ha rvest 36263)

A	80	160	133	122	122	139	145	128	132	98	120	141	93	114	126	66	143	116	145	137	123	112	119	128	133	101	100	122	79	87		3564
M	70	85	110	85	0	127	62	100	62	64	66	65	48	52	68	69	73	49	42	43	38	28	52	51	41	13	45	45	44	47	50	1794
J	40	43	25	48	36	25	25	42	28	14	26	5	24	24	21	25	25	11	17	13	19	18	21	24	22	16	5	15	0	24		681
J	25	16	17	14	16	14	14	9	12	7	5	4	8	8	11	18	17	11	15	21	27	19	23	26	26	35	29	40	39	33	45	604
A	51	46	30	23	25	15	9	21	18	22	14	17	28	12	33	32	37	54	48	30	47	68	72	61	59	63	60	146	140	100	73	1454
S	101	72	121	70	40	39	61	67	37	75	66	60	82	90	78	112	124	121	162	159	144	168	156	187	145	169	162	108	93	87		3156
O	81	64	79	86	58	55	54	59	48	60	44	59	62	83	71	73	102	104	101	148	144	174	141	130	140	119	119	102	115	95	66	2836
N	61	60	76	66	89	78	77	92	124	133	150	165	177	160	152	183	121	151	134	164	134	183	164	171	178	166	145	144	143	151		3992
D	126	105	105	105	102	96	123	112	89	165	127	149	202	155	185	141	152	150	188	150	179	163	150	176	181	177	155	172	152	159	140	4531
J	160	171	135	150	160	113	175	150	152	118	132	188	146	175	157	163	184	182	164	168	200	178	157	145	137	152	145	131	148	176	137	4849
F	133	136	119	120	126	144	176	144	148	162	177	175	188	166	211	150	190	159	152	150	200	183	138	174	163	159	191	119				4453
M	122	155	156	139	113	188	113	106	197	144	128	118	111	150	101	130	156	154	137	152	162	163	198	174	157	141	140	69	205	108	62	4349

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

harvest year 1995/1996 (total egg-ha rvest 36618)

A	152	158	157	117	159	149	64	172	129	101	119	122	117	145	121	144	157	138	150	142	128	118	133	121	124	110	114	109	109	63		3842
M	85	101	78	74	104	88	98	58	142	60	71	90	68	75	65	71	62	63	75	74	73	60	78	80	70	59	53	45	37	44	40	2241
J	40	50	37	38	29	42	31	36	37	43	14	47	37	25	21	39	35	27	15	16	3	0	12	20	80	17	14	11	17	13		846
J	7	11	9	8	2	7	6	6	12	11	7	16	11	12	15	13	11	10	14	19	6	6	0	6	3	15	10	0	7	5	1	266
A	1	9	6	4	3	7	11	5	11	13	16	13	16	26	15	38	34	42	40	21	43	8	21	20	15	9	14	5	8	10	15	499
S	30	37	37	32	43	59	63	58	106	77	122	121	155	139	131	137	87	106	45	79	72	68	74	82	69	64	67	62	75	104		2401
O	91	68	145	148	152	148	200	185	169	141	166	164	155	137	131	127	144	147	164	146	168	117	167	103	141	124	140	107	136	111	127	4369
N	157	162	160	167	160	159	147	164	151	163	179	177	192	158	150	217	160	186	158	175	149	120	164	159	123	163	161	153	119	144		4797
D	192	147	132	146	170	183	147	167	199	171	165	181	185	176	138	159	151	168	151	141	162	174	160	137	125	155	127	164	135	146	148	4902
J	141	168	171	172	133	158	156	148	185	156	147	185	170	159	150	157	160	153	171	137	138	128	155	165	161	168	153	175	173	146	133	4872
F	120	138	145	150	177	162	153	187	204	190	173	180	145	170	141	122	132	132	170	125	165	120	135	127	118	151	152	145				4229
M	136	144	128	121	151	128	122	140	132	133	157	170	139	122	109	100	99	102	81	82	71	65	70	63	70	80	99	88	78	105	69	3354

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

APPENDIX I (continued)

harvest year 1996/1997 (total egg-ha rvest 37712)

A	114	138	147	103	163	187	179	183	124	156	135	97	106	106	87	92	98	83	84	84	86	79	96	101	89	85	102	98	100	92		3394
M	72	73	74	52	88	74	89	91	67	71	59	87	57	52	49	44	42	20	21	12	12	12	24	9	23	16	22	29	35	21	25	1422
J	19	29	12	15	16	13	17	13	17	13	9	20	5	11	5	8	5	7	2	3	1	6	4	5	5	10	4	5	5	0		284
J	4	5	5	1	9	10	2	0	7	4	9	8	1	4	2	2	1	0	1	1	4	2	2	1	3	3	7	6	11	7	14	136
A	13	18	19	22	32	27	29	37	31	8	32	5	14	16	8	6	6	5	5	7	17	8	17	34	41	30	67	75	97	85	98	909
S	66	95	70	104	106	97	202	144	122	93	96	36	64	51	56	48	43	55	65	74	93	106	130	152	162	198	178	152	187	235		3280
O	216	202	192	163	171	135	107	123	102	126	120	95	121	118	134	130	137	151	183	180	181	187	167	170	167	156	181	169	187	204	220	4895
N	179	236	186	179	185	180	153	168	170	131	150	146	148	150	165	154	133	188	158	167	145	144	174	214	213	180	178	221	186	166		5147
D	201	158	190	201	175	181	169	137	147	145	150	149	144	153	155	142	147	180	169	138	137	107	230	194	165	176	166	187	144	201	132	5070
J	166	175	132	130	177	170	177	137	128	111	130	134	152	155	177	133	128	155	156	175	177	180	166	178	175	192	178	170	217	169	194	4994
F	199	152	170	149	143	148	160	108	126	137	150	150	126	134	136	144	151	122	126	134	142	169	190	130	128	162	202	161				4149
M	150	132	83	105	110	102	111	104	93	113	105	150	116	127	136	182	140	107	124	135	178	138	165	145	119	108	126	166	161	138	163	4032
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**		

APPENDIX 2 Basic data on fledgling number s

harvest year 1994/1995 (total number of fledged chicks 3143)

A	no data																															
M	no data																															
J	no data																															
J	12	12	7	11	25	16	14	12	19	12	12	9	12	9	3	9	12	5	15	18	8	12	9	2	11	5	10	5	9	5	5	325
A	1	0	0	1	1	6	11	19	13	18	13	13	8	26	25	20	9	21	31	18	20	13	29	17	11	15	21	9	9	15	12	425
S	16	13	11	9	3	15	14	21	12	11	9	20	9	14	7	2	5	8	5	7	8	4	2	3	2	0	5	4	4	3		246
O	3	0	4	3	7	5	5	7	3	8	6	1	12	4	4	2	4	4	3	1	0	4	2	5	6	4	7	12	5	5	7	143
N	16	10	9	7	6	8	17	9	9	8	11	8	10	7	7	7	9	5	3	6	7	4	7	6	8	7	5	17	17	38		288
D	32	45	43	27	27	13	29	36	31	28	15	14	17	12	13	18	7	13	11	14	13	14	12	14	21	11	8	14	9	12	15	588
J	10	8	12	12	10	9	12	21	15	30	27	20	14	19	12	7	11	6	7	6	6	21	11	20	16	8	9	7	8	4	5	383
F	4	5	11	10	9	7	13	19	14	12	12	14	11	9	10	11	6	12	21	18	6	8	12	14	10	15	14	19				326
M	10	12	0	11	17	7	38	15	11	9	11	9	15	16	23	19	13	12	17	12	12	19	15	11	12	15	14	11	7	14	12	419

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

harvest year 1995/1996 (total number of fledged chicks 2862)

A	10	8	10	15	11	11	18	18	17	20	32	18	27	20	11	18	15	11	11	9	9	12	8	7	18	16	7	11	14	21		433
M	17	12	19	42	32	15	18	28	15	19	15	22	15	19	21	14	22	23	10	15	10	17	15	15	6	10	10	13	13	6	7	515
J	23	15	12	14	34	18	15	15	14	38	22	22	23	13	21	24	14	14	6	20	10	26	11	13	25	15	6	2	12	7		504
J	12	12	7	6	11	6	11	6	10	10	7	9	11	12	7	12	5	8	9	6	12	4	8	2	7	14	11	4	10	12	9	270
A	5	4	8	5	7	6	8	3	6	3	5	8	6	7	4	9	5	2	5	6	2	5	4	4	2	6	3	5	1	3	1	148
S	2	1	0	3	2	4	0	3	2	1	0	3	3	0	1	1	0	2	0	1	0	2	6	1	0	2	3	1	1	0		45
O	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	0	1	0	10
N	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	2	1	2		10
D	0	0	0	0	0	0	0	0	0	1	5	3	3	2	4	4	2	6	11	3	2	2	10	2	12	5	5	8	11	6	6	113
J	8	12	10	8	6	9	11	13	7	13	10	12	6	8	5	6	8	10	5	7	4	2	3	6	8	10	7	4	11	6	3	238
F	4	6	12	7	9	11	8	5	8	4	7	3	10	6	5	3	5	8	4	4	2	6	3	5	7	7	9	5				173
M	6	11	15	23	8	4	10	8	6	5	6	4	7	6	6	4	9	7	7	11	15	15	15	24	14	24	27	16	34	28	28	403

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

APPENDIX 2 (continued)

harvest year 1996/1997 (total number of fledged chicks 3099)

A	0	0	0	0	0	35	19	19	20	32	24	36	27	21	30	19	19	15	22	21	67	39	30	28	46	30	29	20	21	28		697
M	42	33	38	39	31	29	25	24	20	17	9	19	13	13	6	14	13	9	11	10	20	14	12	19	14	24	17	15	15	17	18	600
J	27	11	7	4	2	5	2	2	6	3	3	7	7	3	0	1	0	1	3	1	0	0	0	0	0	0	0	0	0	0		95
J	3	1	7	3	17	6	7	9	0	4	0	15	9	0	2	4	0	4	2	0	5	0	0	0	7	0	0	3	4	0	0	112
A	6	1	2	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	1	0	19
S	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	7		13
O	3	0	1	0	1	0	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	14
N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	3	0	0	0	4	0	1	1	0	0		13
D	5	8	6	3	4	1	0	6	7	0	11	1	19	19	12	8	5	4	24	1	18	11	10	0	16	23	29	31	11	2	11	306
J	22	12	15	12	22	11	11	0	9	10	13	25	22	13	37	12	21	2	14	20	34	14	30	31	11	4	0	12	2	7	0	448
F	1	0	16	10	7	4	3	7	0	17	6	17	18	2	18	17	5	37	26	13	15	24	40	10	21	31	2	29				396
M	4	9	13	11	8	4	7	9	13	17	1	2	0	9	12	5	22	10	18	15	24	10	27	15	14	24	0	25	24	14	20	386

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

APPENDIX 3 Biometrical data

Table 42 Measurements (in mm) taken by C.F.E. Rompas of 10 living adult females of *Eulipoa wallacei* captured at Tanjung Maleo, Haruku Island, October - December 1994 (data from Rompas 1996).

	n	mean	s.d.	range
Bill from feathers	10	19.9	2.32	16.0 - 22.3
Bill from nostril	10	14.8	1.93	12.2 - 17.8
Bill from skull	10	26.3	2.80	21.5 - 31.0
Tarsus	10	58.5	2.74	55.0 - 64.0
Midtoe	10	35.6	2.74	31.5 - 41.8
Midtoe with claw	10	54.3	2.77	49.4 - 60.5
Wing	10	207.6	6.96	200.0 - 221.0
Tail	8	77.9	3.09	73.6 - 81.6
total weight in g	10	481	21.89	450 - 515

Table 43 Measurements (in mm) taken by C.F.E. Rompas of six living newly fledged chicks of *Eulipoa wallacei* at the Tanjung Maleo nesting grounds, Haruku Island, October 1994-March 1995 (data from Rompas 1996).

	n	mean	s.d.	range
Bill from feathers	6	11.6	1.68	10.0 - 13.0
Bill from nostril	6	7.6	1.34	6.3 - 9.5
Bill from skull	4	15.2	1.18	13.5 - 16.4
Tarsus	6	28.2	8.25	23.0 - 32.4
Midtoe	4	19.2	3.50	16.4 - 21.5
Midtoe with claw	4	27.7	5.65	24.8 - 31.4
Wing	3	89.7	21.8	83.0 - 94.0
Tail	4	31.2	0.94	30.5 - 32.0
total weight in g	3	66.8	3.96	61.5 - 71

Table 44 Measurements (in mm) taken by C.F.E. Rompas of six skins of female specimens of *Eulipoa wallacei* in the collection of Museum Zoologicum Bogoriense (MZB): five from Buru, of which four collected by Toxopeus (22/23-XII-1921) and 1 by Tarip (23-II-1922), and one from Halmahera, collected by Vorderman (data from Rompas 1996).

	n	mean	s.d.	range
Bill from nostril	6	17.2	1.88	15.0 - 19.7
Bill from skull	6	30.4	2.11	27.5 - 34.0
Tarsus	5	52.8	4.91	47.0 - 58.3
Midtoe	6	38.1	1.54	36.3 - 40.8
Midtoe with claw	6	54.0	2.19	51.7 - 57.5
Wing	6	197.0	3.47	190.0 - 200.0
Tail	6	75.5	4.63	65.7 - 79.0

Table 45 Measurements (in mm) taken by C.F.E. Rompas of two male specimens of *Eulipoa wallacei* (one adult and one chick) in the collection of Museum Zoologicum Bogoriense (MZB) (data from Rompas 1996).

	adult male, skin de Haan, 24-X-1951 Teliwang, Halmahera collection MZB	male chick, skin Toxopeus, 22-XII-1922 Buru collection MZB
Bill from nostril	21.2	9.3
Bill from skull	31.3	17.3
Tarsus	56.5	28.3
Midtoe	41.6	19.3
Midtoe with claw	65.3	22.9
Wing	190.0	99.0
Tail	86.8	30.0

APPENDIX 4 The chromosome number of *Eulipoa wallacei*

Based on embryonic cells taken from hard-set eggs that originated from Tanjung Maleo (and transported to the Bogor Laboratory) Rompas (1996) established the chromosome number of *Eulipoa wallacei* at 2n = 56 (12 macrochromosomes and 44 microchromosomes). This is the result of the analysis (counts) of 8 metaphases that could be detected (Table 46). Relative lengths of the six largest chromosomes are given in Table 47. Figure 49 depicts a metaphase. Rompas (1996) did not succeed in compiling a representative karyogramme of the species.

There are few data on the chromosome numbers of megapodes. Belterman & de Boer (1984) only listed two species (*Aepypodius arfakianus* and *A. bruijnii*) but *A. bruijnii* was misidentified and appeared to be *A. arfakianus* (R.H.R. Belterman, pers. comm. 1996). The diploid number of the remaining other megapode-species known to cytology (*A. arfakianus*) was approximately 80.

Table 46 Chromosome counts based on 8 metaphases. Most frequent diploid numbers are given, range between brackets (data from Rompas 1996).

macrochromosomes	microchromosomes	total
12 (12-14)	44 (36-52)	56 (48-64)

Table 47 Relative length in % (total length of all chromosomes = 100 %) of 6 macrochromosomes of *Eulipoa wallacei*. Based on 8 metaphases (data from Rompas 1996).

chromosome number	average	range	s.d.
1	13.95	12.50 - 17.34	1.61
2	9.92	9.50 - 10.38	0.29
3	8.74	7.69 - 9.50	0.59
4	6.45	5.80 - 7.20	0.57
5	5.72	4.20 - 6.15	0.60
6	5.21	3.85 - 6.02	0.67

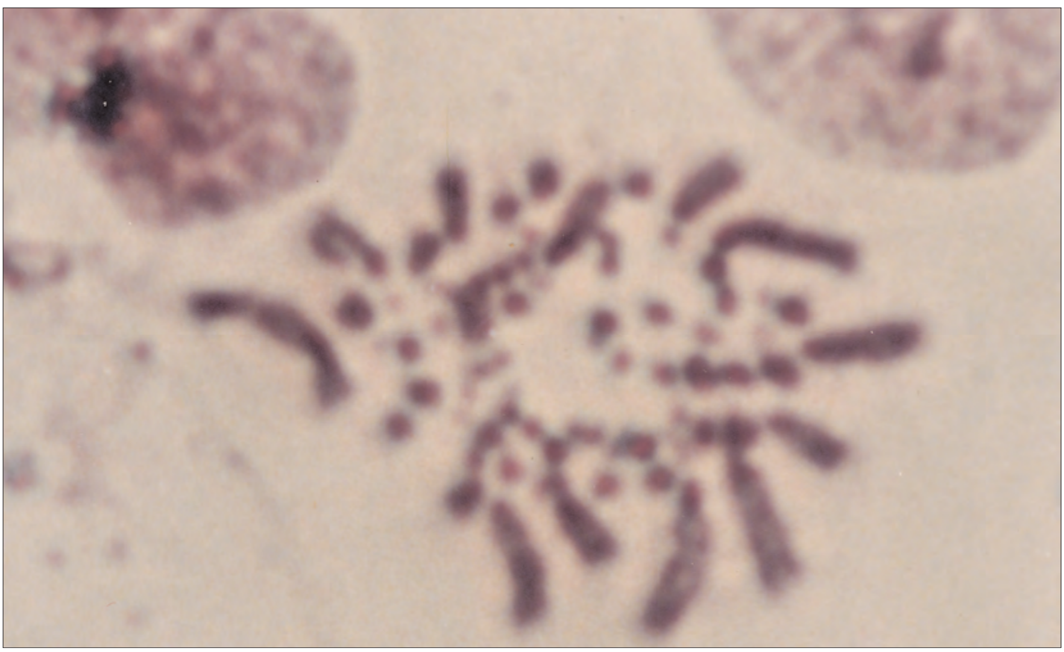

Figure 49 Chromosome pattern of *Eulipoa* wallacei during metaphase. [photo: C.F.E. Rompas]

APPENDIX 5 Local Indonesian names and English names of *Eulipoa wallacei* and sympatrically occurring other megapode

During our study, both in the library and in the field, we encountered many different colloquial names for the same bird: *Eulipoa wallacei*. The same applies to Forsten's megapode *Megapodius forstenii* and to the dusky megapode *Megapodius freycinet*, two species that occur sympatrically with *Eulipoa wallacei*. We observed *Eulipoa* (in the same nesting habitat) next to *M. forstenii* on Haruku, Ambon, Pombo, Kasa, Seram, Boano and Buru, and next to *M. freycinet* on Halmahera. In contacts with local people, the occurrence of two species of megapode in the same habitat is often confusing. Therefore, we have drawn up an inventory of the Indonesian local names of the species concerned. In case a local name is not followed by a reference, the name was obtained from locals at the island or location concerned. For all megapodes occurring in Indonesia, the general name maleo (or a derivation of it) is widely used.

LOCAL NAMES

1 *Eulipoa wallacei*

Ambon, Haruku, Seram, Buru, Halmahera: maleo, burung maleo (burung = bird), muleo, maleo pantai (pantai = beach), moa, moma, momoa and burung gosong.
Appelman (1938) mentioned the nesting mounds of 'burung gosong'. Later he reveals that the natives call the bird 'burung kosong'. This is not a correction, since 'goson' indicates the dull-grey colour of the bird, whereas 'kosong' means empty. Clearly he refers to a mound-breeding species and not to the burrow-nesting *Eulipoa*. We noticed that on Kailolo one often confuses the local names of *Eulipoa wallacei* and *Megapodius forstenii*.
Central Buru: nan'lato (kings bird); man' titin [according to sound: Toxopeus (1922) and label data MZB-Bogor]. Chicks of *Eulipoa wallacei* and *Megapodius forstenii* are both called kéhô (Toxopeus 1922).
North Seram, Manusela park: manulai
Southeast Seram: bilaun
Northwest Halmahera: burung galela
Northeast Halmahera: mamor
Misool: holeiko (Ripley 1960); sagoil (?)

2 *Megapodius forstenii*

Ambon, Haruku, Seram: maleo, maleo hitam (hitam = black), maleo hutan (hutan = forest), mulea, moma, ayam hutan (= woodhen), mamoa hutan, maleo (yang) hitam.
North Seram, Manusela park: baikole
Central Buru: palmeda

3 *Megapodius freycinet*

Halmahera: maleo, maleo hutan, ayam hutan, durung chili, maleo ketjil (Delsman 1951; ketjil = small)
Misool: holeiko (this name also applied to *Aepypodius arfakianus*)

ENGLISH NAMES

1 *Eulipoa wallacei*

In the literature, the English name of *Eulipoa wallacei* is often composed of the adjective Wallace's, Moluccan, Moluccas, or painted, followed by megapode, scrubhen or scrubfowl:

Ogilvie-Grant (1897): Wallace's painted Megapode
Ripley (1964): Wallace's Megapode
Rand & Gilliard (1967): Moluccas Scrub Hen
White & Bruce (1986): Moluccan Scrubfowl
Beehler et al. (1986): Moluccan Scrubfowl
Howard & Moore (1991): Moluccas Scrub Fowl
Sibley & Monroe (1990): Moluccan Scrubfowl
Dekker (1991): Moluccan Megapode
Del Hoyo et al. (1994): Moluccan Scrubfowl
Jones et al. (1995): Moluccan Megapode
Inskipp et al. (1996): Moluccan Scrubfowl

For reasons of uniformity, following the most recent monograph on the family (Jones et al. 1995), we have used the name Moluccan megapode in this study. In the Dutch language we recommend the bird to be called 'Wallace grootpoothoen' and not 'Moluks Boshoen' (Roselaar 1991) or 'Molukkenboshoen' (A.J. van Loon, in: Walters 1997).

2 *Megapodius forstenii*
Howard & Moore (1991): Orange-footed Scrubfowl
White & Bruce (1986): Orange-footed Scrubfowl
Sibley & Monroe (1990): Orange-footed Scrubfowl
MacKinnon & Phillips (1993): Reinwardt's Scrubfowl
Marchant & Higgins (1993): Orange-footed Megapode (Scrubhen, Junglefowl)
Del Hoyo et al. (1994): Orange-footed Scrubfowl
Jones et al. (1995): Forsten's Megapode
Inskipp et al. (1996): Forsten's Scrubfowl

The adjective 'Reinwardt' is now outdated as the taxon is currently considered a full species, and not a subspecies of *Megapodius reinwardt* (see: Roselaar 1994; Jones et al. 1995).

3 *Megapodius freycinet*
Rand & Gilliard (1967): Common Scrub Hen
White & Bruce (1986): Dusky Scrubfowl
Howard & Moore (1991): Dusky Scrubfowl
Sibley & Monroe (1990): Dusky Scrubfowl
Del Hoyo et al. (1994) Dusky Scrubfowl
Jones et al. (1995): Dusky Megapode (Sooty Scrubfowl)
Inskipp et al. (1996): Dusky Scrubfowl