Short introduction to Philippine natural and geological history and its relevance for Lepidoptera

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Abstract: This introduction to the Philippines gives a brief insight into the people, the climate and climatic variations, the forests as well as the biogeography and geological histoty over the past 50 Ma with special reference given to the ice-age and possible impact on species dispersal. Included also are maps illustrating the names and relative positions of the islands comprising the Philippines as used in this Supplementum; the current position of the Philippines with respect to neighbouring countries; and a biogeographic map showing the faunal regions of the Philippines. In addition, a code list of the abbreviations of the islands of the Philippines is provided.

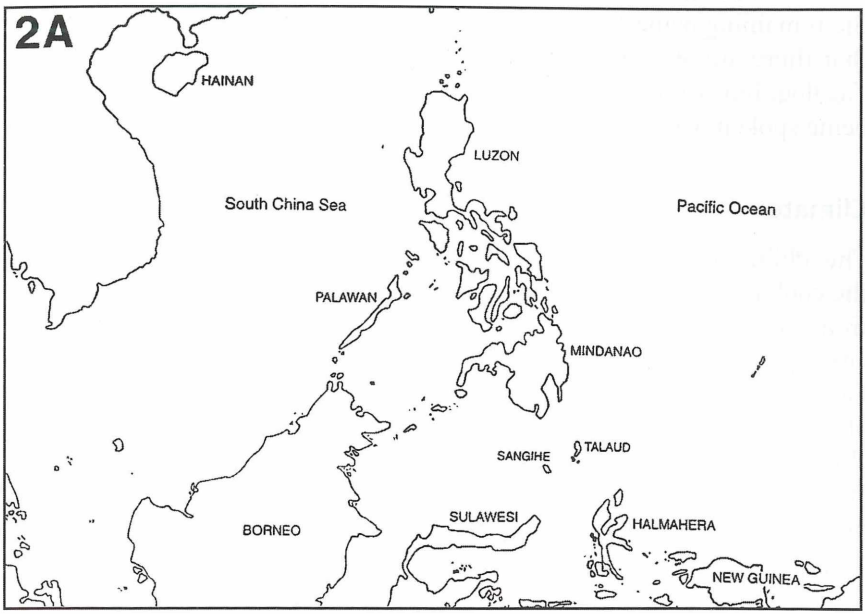
Allgemeine Einführung in die Philippinen

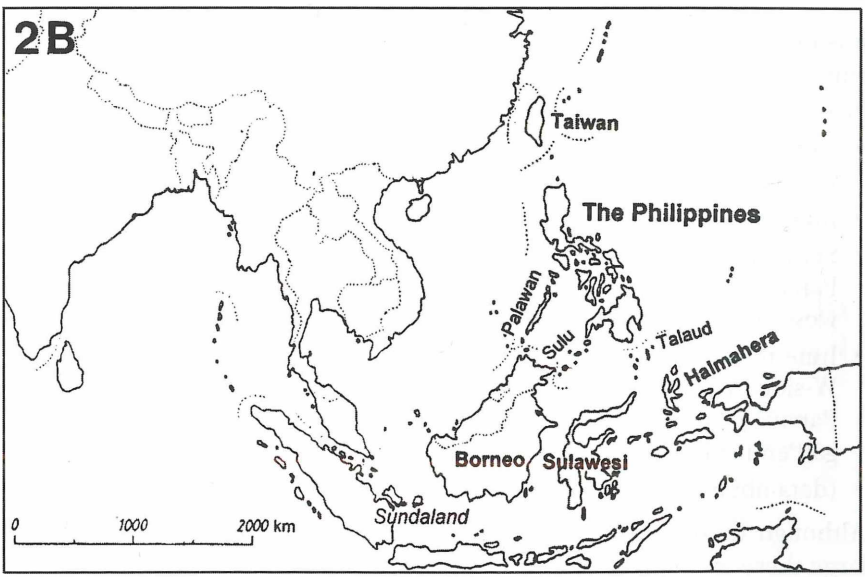
Zusammenfassung: Diese allgemeine Einleitung in die Philippinen gibt einen kurzen Überblick über die Bevölkerung, das Klima und Wetter und die Wälder der Philippinen sowie über ihre biogeografische und geologische Historie über die letzten 50 Jahrmillionen, mit besonderem Schwerpunkt auf den Eiszeiten und ihrem möglichen Einfluß auf die Verbreitung der Arten. Beigefügt sind Karten mit den Namen der größeren Inseln, mit der Lage der Philippinen im Vergleich zu unliegenden Landmassen und mit den biogeografischen Regionen der Philippinen. Eine Tabelle mit den Abkürzungen der Inselnamen, wie sie im Supplementum gebraucht werden, ist beigefügt.

Geography and people

The Philippine Islands (Figs. 1, 2) are situated between latitude 4° 26′ and 21° 07′ north of the equator (1830 km) and between longitude 116° 57′ E and 126° 38′ E (1062 km). There are 7107 islands of which only around 2100 are said to be inhabited. About one third of the islands are not listed by name in the usual reference books or maps. Only about 500 islands have an area of over one km^2 The eleven largest islands account for 96 % of the land area of the Philippines. The largest three islands in order of size are Luzon, Mindanao and Palawan. The highest mountain is Mt. Apo (2954 m) in Southeast Mindanao. Seventeen active volcanoes are officially recognized with eruptions occurring quite frequently (PETERS 1986). At this time there were considered to be 65

Fig. 1: Map of the Philippines with the larger islands identified.





Figs. 2A, 2B: Maps of the Philippines showing its position in relation to the surrounding islands, to different scales. Scales in km.

million inhabitants of whom approximately 89 % being Christians with the remaining being Moslem as well as minority groups. It is worth noting that there are 60 ethnic groups in the country. The national language is Tagalog, but a total of 80 languages and dialects are currently listed as being spoken within the boundaries of the country (PETERS 1986).

Climate

The Philippines experiences a tropical climate with generally speaking the cooler, drier period from December to February, the hot, drier period from March to May and a rainy season from June to November. In this latter period, strong typhoons can be quite destructive, especially in the East Visayan and North Luzon areas. Further, many of the larger islands of the Philippines can experience differing intensities of the general climatic conditions depending on the location of higher mountain ranges and the amount of forest coverage existing. If we add to this the prevailing winds over the year

- from the southwest, May to September;
- from the north and northeast, October through to January;
- from the east and southeast, February to April

it is not surprising that each of the major islands can experience differing climatic conditions for different parts of the island. For example, the heaviest rainfall occurs from

- November to January for E-Mindanao, E-Leyte, E-Samar and SE-Luzon;
- June to October for W-Luzon, W-Palawan, W-Mindoro and W-Negros;
- September to November for the central part of N-Luzon, Masbate, E-Panay, Marinduque, Romblon Group, E-Negros, S-Cebu and the western coastal area of the Zamboanga Peninsula;
- June to January for the E-side of N-Luzon, the W-side of S-Luzon, the W-side of Leyte, the W-side of N-Samar, Bohol, N-Cebu, N-Negros, N-Panay, E-Mindoro and C- and S-Mindanao, the E-side of the Zamboanga Peninsula and the Sulu Archipelago
- (data obtained from a Philippine Airlines weather information chart).

Although there are drier and wetter periods on the Philippines, by and large there are no distinctly long dry periods where one could expect dry season Lepidoptera forms to be established. Occasionally, an island or part of an island will experience a prolonged dry period.

Forests

Whereas the Philippines is noted in reference books for its extensive forest coverage, this situation has certainly changed over the past 30 years. Space requirements for the explosive population increase coupled with the world demand for timber and the modern wood harvesting methods now used have resulted in substantially reducing the forest areas of the Philippines, particularly lowland forest. Recently (LEWIS 1990) it was estimated that less than 10 % of the original forest coverage of 50 years ago remains. Notwithstanding, reasonably large forested areas can still be found in such locations as NE-Luzon and the Sierra Madre Mountain Range of E-Luzon, parts of Palawan, S-Mindanao, C-Mindanao (Bukidnon), N-Negros, C-Leyte, N- and C-Samar and E-Tawitawi Island. The higher mountains across the country tend to have at least some forested slopes. Typical examples are Mt. Apo (Mindanao, 2954 m), Mt. Pulog (Luzon, 2934 m), Mt. Halcon (Mindoro, 2585 m), Mt. Canlaon (Negros, 2465 m), Mt. Isarog (Luzon, 1966 m), Mt. Guiting Guiting (Sibuyan, 2057 m), Mt. Malindang (Mindanao, 2425 m), Mt. Mantalingajan (Palawan, 2085 m) and Mt. Kitanglad (Mindanao, 2938 m). Further, there are in existence 61 national parks and protected areas. Nevertheless it has been forecasted that if the current rate of deforestation continues (between 353 000 to 525 000 acres per year, or more dramatically stated: between 0.7 and 1 acre every minute (ANONYMOUS 1991) the Philippines will be without true forest shortly after the turn of the century. This will, of course, have a very strong impact on all forms of life including forest dwelling lepidoptera.

Biogeography of the Philippines

Biogeography and geological history over the past 50 Ma[1]

The formation of the Philippine Island Group geologically is considered to be extremely complex. It would seem that by far the greater part of the islands emerged at some period out of the sea and at no time formed part of a large island mass. There have been a number of hypotheses concerning the stepwise formation of the Philippines. Perhaps the most interesting and recent approach was established by HALL & BLUNDELL (1996). HALL (1996) in his reconstruction of Cenozoic SE Asia starts with the early Eocene period (50 Ma) in which the initial creation of a number of Philippine

1 Ma = 1 million years before current time ("M" from mega, meaning "one million of the unit"; from annus, Latin for "year").

islands seems to have been heavily influenced by the clockwise movement of the Philippine Sea Plate and the arc activity at the southern edge (about 15° south of the equator). While the East Philippine Islands were being thus initially formed, another island, Zamboanga (today Zamboanga Peninsula as part of Mindanao) existed on the equator at about longitude 129° E, somewhat south of its current position. At the same time Mindoro, Calamian and N-Palawan were located on the east edge of the Eurasian Plate, but stretching just south of Taiwan in their current north-south order. By the middle Eocene period (45 Ma) he considered that what were to be the Central and Southern Philippine Islands were being steadily influenced by the continued movement of the Philippine Sea Plate and known motions of the Indian-Australian Plate to the south of the Philippine Sea Plate which forced a strong northwest movement of these islands. At about the same era what is now N- and C-Luzon was forced up out of the sea east of Zamboanga Island, but surprisingly with an east-west axis. Further the Sulu Archipelago was considered to have existed by 45 Ma. During this middle Eocene (45 Ma) to the early and mid-Oligocene (40-30 Ma) the Central and Southern Philippine Islands further developed and moved increasingly northwest. Additionally, by the mid-Oligocene (30 Ma) Luzon in turn had started to move northward and to rotate in an anti-clockwise direction brought about by activity of the Eurasian Plate, the Philippine Sea Plate and the Pacific Plate. Further, he considered that the Mindoro, Calamian and N-Palawan Group of Islands began at this time their steady movement southwards. By the early Miocene (20 Ma) Luzon had assumed its north-south axis position, but still had to move further north to match its current location. The Central and Southern Islands were further formed and had also moved northward reaching almost to the equator. By the middle Miocene (15 Ma) the Mindoro, Calamian and N-Palawan complex in their southern movement were on a parallel with Luzon which itself had continued to move northwards as did the Central, Eastern and Southern Islands of the Philippines. Zamboanga Island and the Sulu Archipelago Islands maintained their position with respect to Borneo by moving somewhat northward in step with Borneo. Between the late Miocene (10 Ma) and the end of the Miocene (5 Ma) the Philippines began to come close to its current status. However, the N-Palawan, Calamian, Mindoro Island complex still had to move somewhat more southwards as well as eastwards to be positioned as today between Luzon and Borneo. S-Luzon which had moved up from the south was now joined to the rest of Luzon. However, Negros was still considered to be attached at the southern end to Central

Mindanao, but shortly thereafter separated. Mindanao as such had moved up to join with Zamboanga Island creating the Zamboanga Peninsula. Samar, Leyte, Bohol, Cebu and Panay were also poised for positioning in their current locations. The whole being influenced by movements of the Philippine trench and Manila trench. HALL believes that strike-slip faulting has played a major role in the creation of the Philippines (HALL 1996: 179).

As mentioned above, there have been a number of differing conjectures as to how and when the Philippine Islands as we know them today, were formed. HALL's 1996 approach is certainly an intriguing one. However, as he himself states, "differing opinions are partly a consequence of different interpretations of inadequate data" (HALL 1996: 179).

Biogeography and the ice-age

At this point, let us consider the possibility of lepidoptera, through dispersal, moving from land areas outside the Philippines into the Philippines and vice versa in recent times. The evaluation of this dispersal approach was covered in some detail by DE JONG & TREADAWAY (1993). Certainly, the repeated lowering of the sea level during the Pleistocene ice-age had a large impact on island shapes and sizes as well as the width of water stretches between islands. In the late Pleistocene, some 18,000 years ago, the sea level in this area is considered to have sunk by about 120 m. "In the late middle Pleistocene, about 160,000 years ago, the sea level has been estimated to have dropped by about 160–180 m below present" (DE JONG & TREADAWAY 1993: 88). Such changes dramatically increased the size of islands, perhaps temporarily even joining some together and certainly reducing the water gap between many islands. Such lowering as well as subsequent raising of the sea level must have affected lepidoptera dispersal and isolation. Throughout such periods of lower sea level a number of so-called land bridges were periodically created and later through raising of the sea level became defunct or considerably less effective. Specific for the Philippines were the following intermittent/partial connections:

- through Taiwan, the Batan Islands and the Babuyan Islands to Luzon;
- from Borneo through Balabac, Palawan and the Calamian group to Mindoro with a possible side branch from Palawan through the Cuyo Islands to Panay;
- from Borneo through the Sulu Archipelago to W Mindanao (Zamboanga Peninsula);
- from NE Sulawesi through the Sangir Islands and Sarangani Islands to S Mindanao;

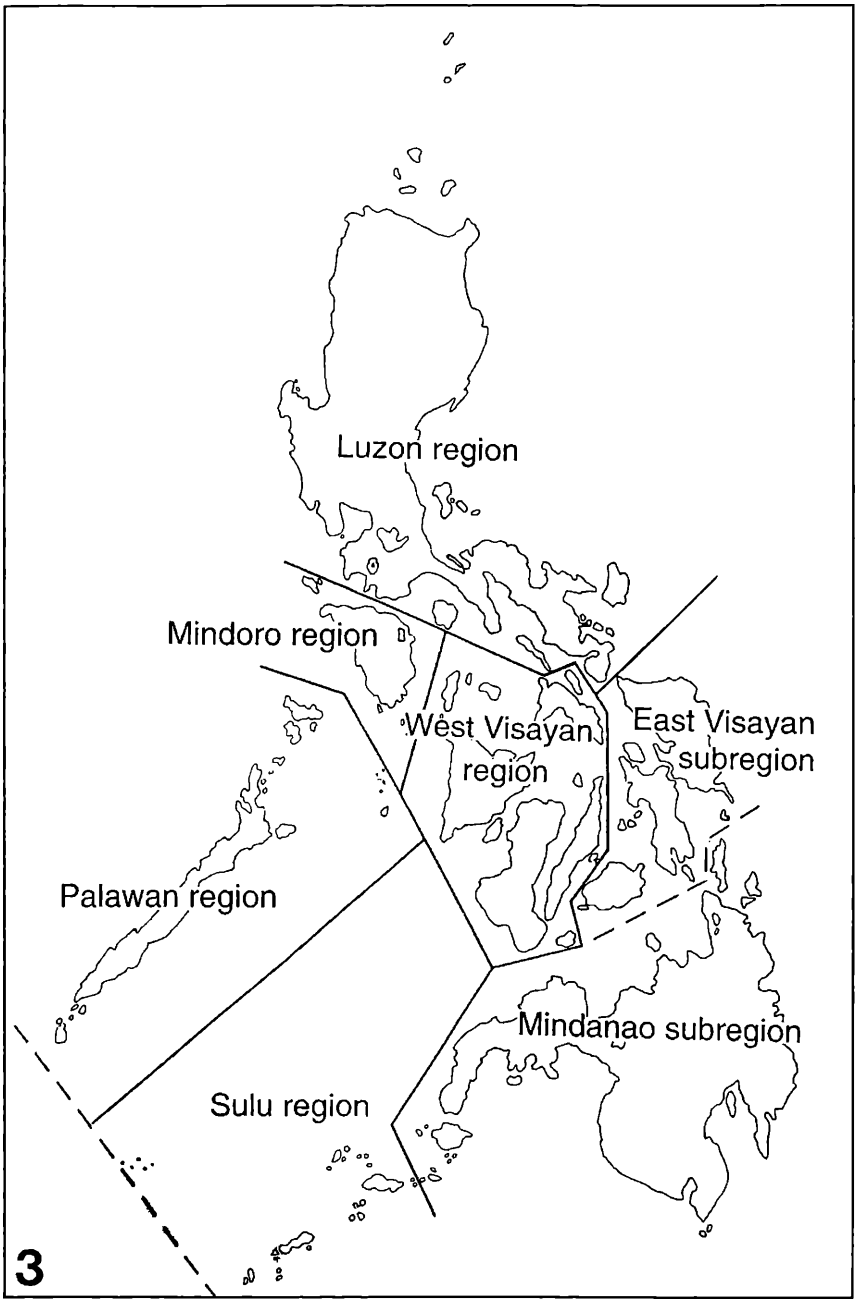


Fig. 3: Faunal regions of the Philippines recognized by VANE-WRIGHT (1990).

- from Halmahera through the Talaud Archipelago to SE Mindanao;

with the second and third bridges assumed to have been the most effective and easiest to visualize today (DE JONG & TREADAWAY 1993). As could be expected, Palawan Lepidoptera, in general, show a strong relationship to Borneo. At a later date (when more data is available) it would be interesting to make the same comparison with Sphingidae, Lasiocampidae and Saturniidae as was made by DE JONG & TREADAWAY (1993) for Hesperiidae with respect to effectiveness of the above mentioned land bridges. The Philippines would certainly seem to be a rich location for further biogeological studies: Old traits from the plate tectonic events during mesozoic and cenozoic times and new traits from pleistocenic sea level fluctuations overlap, most likely to different degrees in different groups.

As Fig. 3 we have reproduced VANE-WRIGHT's (1990) biogeographic map in which, based on a consensus of mammal, bird and butterfly regionalization by several authors, he divides the Philippines into a number of faunal regions. It is of interest to note that the East Visayan subregion and the Mindanao subregion together form the Mindanao region. The Sulu Archipelago is a separate region or a subregion of Borneo with the position of the dividing line through the Sulu Archipelago still being open to question. The Palawan region is considered part of the Greater Sundas (or Sundaland). HEANEY (1986) found that these faunal regions coincided with the extent of land during a fall of the sea level of 120 m in the late Pleistocene, i.e. about 18,000 years ago.

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Table 1: Abbreviations – code list of the islands of the Philippines as used within this Supplementum issue.

Ala	Alabat	Lub	Lubang
Bab	Babuyan	Luz	Luzon
Bal	Balabac	Mar	Marinduque
Bat	Batanes	Mas	Masbate
Bas	Basilan	Mdo	Mindoro
Bil	Biliran	Mno	Mindanao
Boh	Bohol	Neg	Negros
Bon	Bongao	Pal	Palawan
Bur	Burias	Pan	Panay
Bus	Busuanga	Pao	Panaon
CagSul	Cagayan Sulu	Phil	Philippines
Cal	Calamian	Pol	Polillo
Cam	Camarindes Norte	Rom	Romblon
CmL	Camiguin de Luzon	Sam	Samar
CmM	Camiguin de Mindanao	Sar	Sarangani
Cat	Catanduanes	Sga	Sanga Sanga
Ceb	Cebu	Sia	Siargo
Cts	Camotes	Sib	Sibuyan
Cuy	Cuyo	Siq	Siquijor
Din	Dinagat	Sis	Siasi
Dum	Dumaran	Stu	Sibutu
Gui	Guimaras	Sul	Sulu Archipelago
Hom	Homonhon	Tab	Tablas
Itb	Itbayat	Taw	Tawitawi
Jol	Jolo	Tic	Ticao
Ley	Leyte		

Additional abbreviations:

N, W, S, E = North, West, South, East C = Central

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