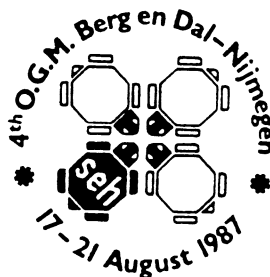


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Geographic variation in the Cobras of the genus *Naja* in southeast Asia: a multivariate analysis.

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INTRODUCTION

The taxonomy of the Asiatic cobras of the genus *Naja* has always been subject to confusion and controversy. One of the regions where this confusion has been particularly acute is the south-eastern part of the group's range, ie. Malaysia and Indonesia. According to the most generally accepted classification (Klemmer, 1963; Leviton, 1968; Golay, 1983), all the populations in this region belong to the species *Naja naja*, the distribution of the subspecies being as follows: *Naja naja kaouthia* occurs throughout Thailand and in the northern part of Malaysia; *N. n. sputatrix* inhabits most of Malaysia, the Riau Archipelago, Bangka, Java and the islands to the east thereof, and *N. n. sumatrana* is endemic to Sumatra. In the only revision of the entire complex so far performed, Deraniyagala (1960, 1961) considered the forms *kaouthia* and *sputatrix* to be separate species, the former occurring in Thailand, and the latter in Malaysia, Sumatra and Java. The Malaysian populations were considered to be a separate subspecies, *N. s. malayae*. Due to the numerous shortcomings of these papers, Deraniyagala's work on the cobras of S.E. Asia has been largely ignored by later workers.

This study examines the interrelationships of the cobras of southern Thailand, Sumatra, Java and Komodo, using multivariate analysis of a large number of quantitative characters.

MATERIALS AND METHODS

Over 100 characters relating to scalation, colour pattern, dentition, internal anatomy and body proportions were recorded from a large number of specimens. Seventeen meristic characters showing geographic variation were selected for this preliminary analysis. In order to avoid any distortion caused by sexual dimorphism, only male specimens were considered. The ventral scales were numbered, and the position of the internal characters was defined by the number of the adjacent ventral scale. In order to overcome any problems due to variation in the ventral scale counts in different specimens and populations, this was then expressed and analysed as % ventral scale (%VS) position.

The following characters were used:

No. of ventral scales; no. of subcaudal scales; no. of cuneates (total of both sides); no. of dorsal scale rows at VS 10; no. of dorsal scale rows at 20% VS length; no. of dorsal scale rows at 40% VS length; no. of undivided subcaudals; %VS position of posterior heart tip; %VS position of systemic junction; %VS position of anterior liver tip; %VS position of posterior liver tip; %VS position of anterior tip of pancreas; %VS position of anterior tip of right kidney; %VS position of anterior tip of left kidney; %VS position of posterior tip of left testis; no. of pterygoid teeth; %VS position of last light ventral of throat.

The specimens involved were grouped into geographic units on the basis of collecting gaps, and the units were tested for homogeneity.

The localities selected were as follows (fig. 1)

(A) Bangkok, Thailand; (B) Phuket, S. Thailand; (C) Kedah and Penang, NW. Malaysia; (D) Kota Baharu, Kelantan, NE. Malaysia; (E) Kelantan state, NE. Malaysia; (F) Kuala Lumpur and Temerloh, C. Malaysia; (G) Southern Malaysia; (H) Singapore; (I) Medan, NE. Sumatra; (J) Padang, W. Sumatra; (K) Lebongtandai, SW. Sumatra; (L) Depok, W. Java; (M) Bogor, W. Java; (N) Garut, W. Java; (O) E. Java; (P) Komodo island.

The interrelationships of the geographic populations are summarized by canonical variate analysis. This technique considers all the characters simultaneously, taking into account their within-group covariance, and maximises the separation of the groups in relation to the within-group variation. For reviews of the use of this technique in studying geographic variation, see Thorpe (1976, 1983).

RESULTS AND DISCUSSION

The canonical variate analysis (fig.2) clearly indicates that there are three distinct forms of cobra occurring in the area under consideration: a northern form, which ranges from mainland Thailand into northern Malaysia (groups A-D), a south-western form, which occurs in Peninsular Malaysia and on Sumatra (groups E-K), and a south-eastern form which inhabits Java and the islands to the east thereof (groups L-P).

The ordination thus obtained is consistent with the geographic variation of a number of other characters not included in this analysis, such as hood markings, throat pattern and the shape of the frontal shield. It is also much more consistent with zoogeographic considerations than the traditional version, since Malaysia is situated much closer to Sumatra than to Java. During the Pleistocene, sea-levels worldwide fell by 120-170 metres (Heaney, 1985; Ollier, 1985), exposing much of the Sunda Shelf and

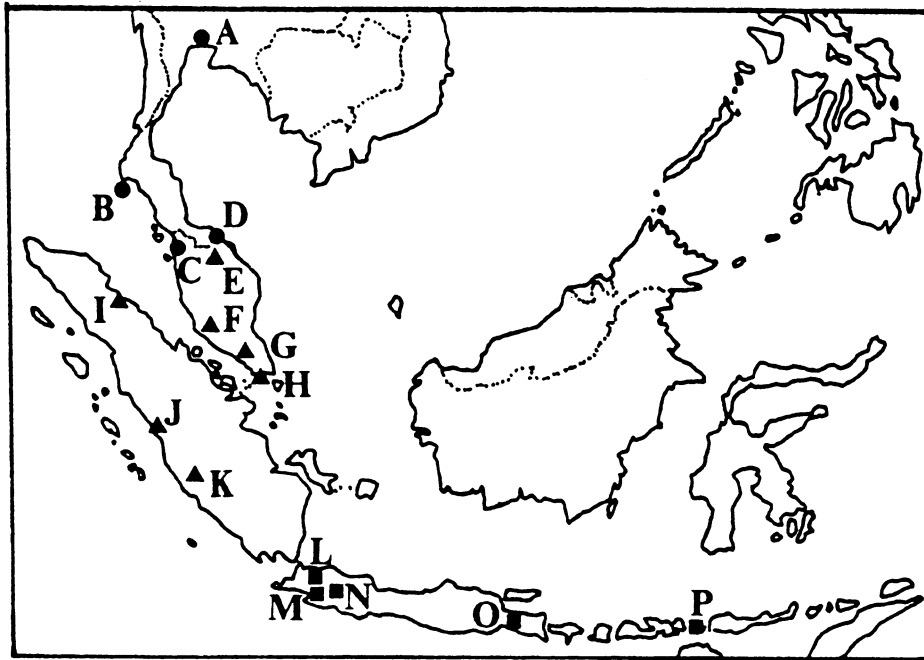


Fig. 1 Distribution of sample localities (see text for details).

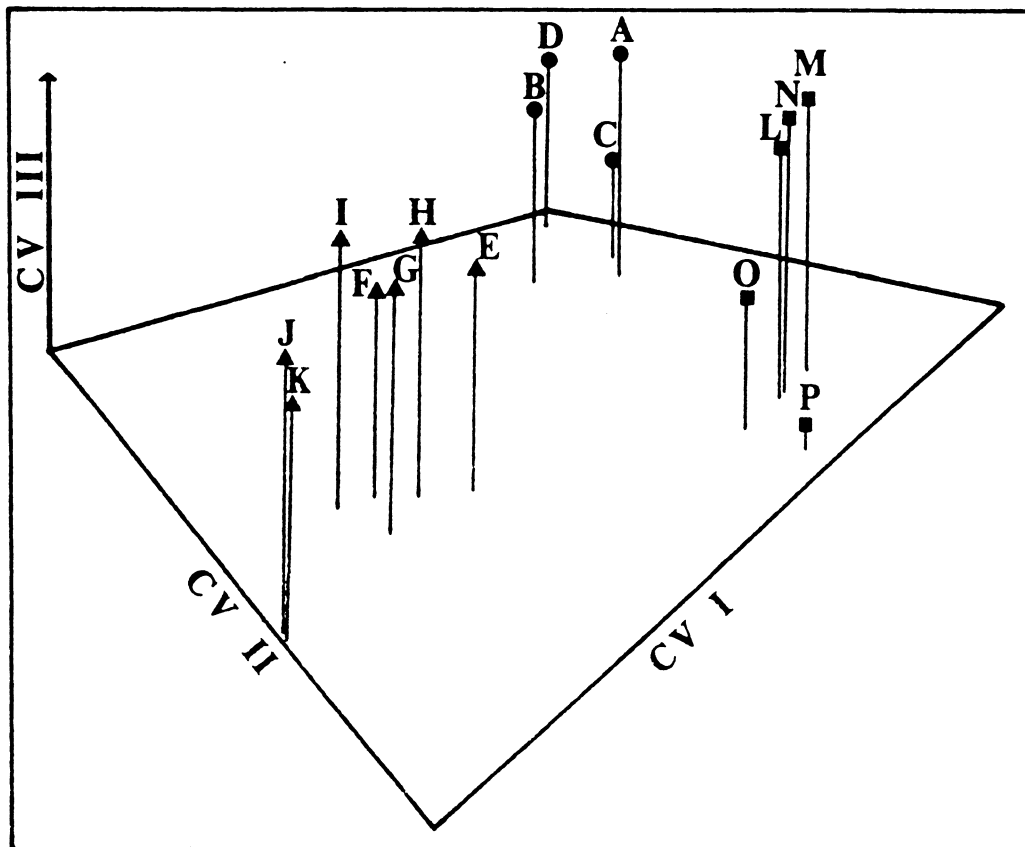


Fig. 2 Ordination of SE. Asian *Naja* populations on the first three canonical variants.

forming extensive landbridges between Malaysia and the western islands of Indonesia (Ollier, 1985). The great similarity between the cobras of NE. Sumatra and Peninsular Malaysia is thus not surprising.

The canonical analysis clearly shows that sputatrix, as generally accepted, is not a valid taxon; the Malaysian populations usually assigned to this form are much closer to the Sumatran form. However, any definite changes in nomenclature will have to await further study of the phylogeny of the entire Asiatic Naja complex.

The question of whether or not there is sympatry or intergradation between the two forms occurring in Malaysia, and thus whether they should receive specific or subspecific status, is currently the subject of further investigations.

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